REVIEW OF MAJOR SPACE PROGRAM STUDIES AND RECOMMENDATIONS MADE TO BUSH TRANSITION TEAM

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

OF THE

COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

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*Ranking Republican Member.

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REVIEW OF MAJOR SPACE PROGRAM STUDIES AND RECOMMENDATIONS MADE TO BUSH TRANSITION TEAM

WEDNESDAY, FEBRUARY 8, 1989

House of Representatives,
Committee on Science, Space, and Technology,
Subcommittee on Space Science and Applications,
Washington, D.C.

The subcommittee met, pursuant to call, at 1:10 p.m., in room 2325, Rayburn House Office Building, Hon. Bill Nelson [chairman of the subcommittee] presiding.

Mr. Nelson. Good afternoon.

Today and tomorrow, this subcommittee will hold hearings to review a number of space policy studies that have been submitted to the transition team.

Could somebody close those doors, please.

One year ago, this subcommittee held hearings in New Hampshire and then again in Iowa to review the major issues concerning space. Particularly we did so because of the fact that somewhere in those two States at that particular time was the next President, and we had a rather extraordinary amount of attention.

At the University of New Hampshire, which Bob Smith was our host, and then at the University of Iowa where, unbelievably, we had a crowd of some 450 people that Dave Nagle had arranged for us, and so little by little and perhaps through circuitous routes the presidential candidates got the message, even though at that time they were not prepared to make any basic statements on space.

Well, since that time, certain commitments have been made to the space program, and we're starting to see the leadership emerge in this new administration, the leadership that is going to basically be proffering the ideas and recommendations that are going to be the space policy that will carry us on into the next century.

Now the President faces some formidable challenges. What we want to do in our role as a subcommittee is to try to help the administration as they review their options for what is to be the space policy of this country, and so this hearing today and the one tomorrow will provide a forum for discussing those options.

We—and I stated last week in my opening comments that we want to see a very strong science advisor. We want to see that office in the White Office be given the respect and deference that it needs, and I made a commentary last week. It would be nice, recognizing that the future of this Nation depends in large part on our science and technology policy, our R&D efforts, if, along with the appointment of an advisor on the Council of Economic Advisors, there would be the appointment likewise as the science advisor, and I think that's going to be forthcoming, and I think it's going to be forthcoming soon.

We want to see a strong NASA administrator. We want to see a NASA administrator given the respect that he is due as the leader of the civilian space program. We want to see that NASA administrator have access to the Oval Office, as he should, instead of being precluded, and cut out, and elbowed aside in these petty, little, bureaucratic turf wars that go on in Washington, and we want to see a strong Space Council appointed early in this administration so that we can get on with the business of managing the space program and setting its policy.

Indeed, there are some decisions that the President will need to make in the coming months that are going to require that his team be firmly in place, and so I have been concerned about the attention that the space program—the lack thereof that it has been getting early in this administration and yet has some encouraging signs, for it was just this morning that I visited with the Vice President, and I found him to be exceptionally receptive. I found him to be involved in details and have a working knowledge of those details, and in the meeting between us I think I conveyed to him the intent of this committee to cooperate with the administration in hammering out the policy and to let him know that this committee, as the authorizing committee, is definitely going to be involved and offer our assistance to him.

I was quite encouraged in this meeting with Vice President Quayle, who, as you know, under the portion that we passed in the NASA authorization bill last year, now law, will sit as the chairman of the National Space Council. So I bring you that timely information.

Now tomorrow evening, the President is going to address the Union, and he is going to lay out his agenda, and then he is going to lay out his budget. I think, I believe, I certainly hope, that the space program is going to be part of his long-range vision for this country. There's no doubt about it to any one of us in this room; all you have to do is go beyond the Beltway and Washington and talk to the American people, and you know that the American people want nothing less than an aggressive space program.

So it was with all that in mind that we conceived this set of hearings, and over the next two days we're going to hear from many experts who've taken the time to contribute their own ideas to the transition team in this administration and to offer their own personal view of what their vision for America's space program should be.

The studies that we're going to review are those studies that have been developed by this impressive list of witnesses, which come from all walks of life—business leaders, eminent scientists, engineers, astronauts, and other Members of Congress. These studies represent the best thinking from the very best people available, and what we need now is for the administration to take those ideas that are workable and forge an agenda in space and a commitment to follow through on that agenda.

So we are looking forward to our testimony today and tomorrow, and I want to turn to my colleague, our Ranking Republican Member, Mr. Sensenbrenner, for his comments.

Mr. **Sensenbrenner**. Thank you very much, Mr. Chairman, and it certainly is a pleasure welcoming the witnesses that will be appearing at today's hearing to give us and, I assume, the President their ideas of what the priorities of the space program should be.

It's my feeling that in order to prevent the space program from being "Weinbergerized," we're going to have to set priorities and to stick to those priorities, because obviously we don't have the money in the budget to do everything we want to do and to do it yesterday. So priority setting is really the key.

The conclusions of the reports that we will be hearing in the next two days, if adopted, would significantly reorder not only the funding priorities of this administration and the Congress but also suggest that we reexamine the adequacy of the space shuttle, the research priorities of the space station, the viability of commercializing space activities, the organization of space policy within the administration, the manner in which Congress considers the annual budget, and even whether or not there will be an annual budget. In other words, Mr. Chairman, I don't think we'll run out of things to talk about today.

I'd also like to note that we Republicans have eight members here and you in the majority party have only two. It shows, I think, that we Republicans are approaching this subject with a full deck. I hope that this does not indicate a lack of interest on the part of the majority party on space priorities. I know that it does not indicate any lack of interest on your part. But certainly we're going to be here participating and coming in with both feet on the ground and with both feet running.

So, again, thanks to you and today's witnesses, and I look forward to hearing from them.

Mr. **Nelson**. Our first panel, Dr. Bodde and Dr. Stever, I want you all to know—and you've been briefed—we want you to share with us, we don't want you reading some written statement, we want you to share your ideas with us, and then we will get on in to the specific questions and a dialogue ensuing therefrom.

So let's start with the executive director of the Commission on Engineering and Technology Systems from the National Research Council, Dr. David Bodde.

STATEMENTS OF DR. DAVID L. BODDE, EXECUTIVE DIRECTOR, COMMISSION ON ENGINEERING AND TECHNOLOGY SYSTEMS, NATIONAL RESEARCH COUNCIL; AND DR. H. GUYFORD STEVER, CHAIRMAN, COMMITTEE ON SPACE POLICY, NATIONAL RESEARCH COUNCIL

Dr. **Bodde**. Mr. Chairman, we have a single statement that Dr. Stever is prepared to present to you.

Mr. **Nelson**. Okay.

Dr. Stever.

Dr. **Stever**. Mr. Chairman, thank you very much. We're pleased to be with you today, and, commenting on your opening remarks, we are very pleased to hear the substance of that and hope that you can carry through on some of those drives.

We would really like to have you put two things in your record, if you would. One is the statement, the brief statement, that we have here, which you've asked us not to read, and the second one is the report of our committee which was published by the National Academy of Sciences and Academy of Engineering.

Mr. **Nelson**. Without objection.

Dr. **Stever**. Thank you.

It's an exception in the activity of the Academy this year. This year, four white papers were prepared for transition. That's the first time that has been done. We are very pleased that the space program was selected as one of the subjects of those white papers.

We're getting back on track in the space program with the two new launches of the space shuttle, Discovery and Atlantis, and we're started on another important thing, the expendable launch fleet development. How far we've gone on that is, of course, a question that we should be asked, and we hope it proceeds apace.

But this beginning of the return, this is a watershed. It's more than a watershed, due to the budget crunch that we're all in; it's a watershed because we're returning to space after two and a half years. We've accomplished so much. Space has been a fabulously successful program for three decades, and I want to begin by saying we should be grateful and express it to the people of NASA and the other parts of the Government that brought this off.

On the other hand, there are some problems, partly because the watersheds that I just mentioned actually conflict with one another, getting back on track, full bore, and having a tight budget.

So we think that the most important thing for you to keep hammering away at is the real goals of our space program and the problem of making them very clear to everybody in the Government—that's the administration and Congress—and to the people of the country, what are the goals this country is pursuing in space, and a second thing, which is equally important, is setting the priorities within those goals and a timetable which is realistic.

In fact, that unrealistic timetable is something that we have to talk about, because a lot of the problems we're in at the present time essentially come because we had an unrealistic set of priorities, if they are priorities expressed in the budget, with respect to the goals, and the current space goals that the administration put out a year or so ago have everything in space as a goal, and there's no sense of priorities there, and so that's the—to match your priorities with those goals and to—and to sell the goals to the people of the country.

You've said that the people are very receptive to a lot of those goals, although you will find when you talk to individuals in the country and even in the individuals in the space community itself, one group is for this, one group is for that, and you know what happens when you have to set tight budgets in such circumstances.

We think America's goals for space should include, could include, a balance of science, global monitoring, human exploration, and so on. Let me talk briefly about each of these.

Space science: We've had remarkable success in our space science program, and there is a backlog of programs to be launched on the shuttle that, if they succeed, they'll knock your eye out—they're very exciting—in the astronomical observatories and so on.

Automated vehicles, the nonmanned vehicles to planets and so on: We've also had remarkable success there, but we haven't started so many of those in recent times, and I think we've got to be very careful to get going on them.

Let's not forget that the automated, unmanned vehicles carry with them the research programs on the sensors and on all the automated equipment and so on which is so important, and lots of interest—industry and other people in the country would like to see the space program carrying a good leadership role in this kind of automation and sensor development. Obviously, they do work on it, but if we're not careful and we don't get our fair share of unmanned vehicles in the business we're going to lose that.

Mission to Planet Earth: A very important question. There are a number of people—and I'll mention here a little later one of the other white papers. A number of people really believe that that, the whole business of the long-term future of our global environment, is one of the most important scientific and technological problems we should address, and NASA and the space program has an important role to play. It's been well advertised. I don't have to spell it out, but satellites can monitor terrestrial conditions, the ozone layer, concentration of greenhouse gases; already NASA is playing an important role.

It's a little too bad when you look at this environmental problem that some elements of government carry the capability to study and do the research as to what the real effects are and other elements of the Government have the responsibility for doing something about them, and they don't meet often enough. That's a general comment that one should look at very carefully to improve over the next years something that this Government could do with respect to our environment.

Human exploration: It's the most exciting to most people and also the most controversial problem in our space program. I think you've heard many people—scientists, engineers, students, fellow Congressmen, administrators, everybody else—wax poetic about the drive of the human race to understand and to explore and so on. It's there, and no one should deny it.

However—and, by the way, we think—our committee and the Academy—think that the space station is more intimately linked in the long run to human exploration than anything else. We think that's the primary reason for being—having a space station. It's needed to study the biomedical things which are needed to know whether man can ever go for a long time in a weightless condition; and, secondly, it's needed to develop the practical devices which he'll need if he goes. Those are very important objectives of the space station. If you delay the space station, you delay human exploration. That goes right back to your goals—goals, priorities, space station, and so on.

Obviously, the space station is represented as man—not a man, a thing of all seasons. It's also a platform for work on micro-gravity and soon, and it certainly can do it, and if it's there it should be included, but we do not think that that's the primary reason for a space station.

I've talked about balancing goals and deficit reduction, and, of course, the first thing that this new administration and this new Congress will face is the station. That's the big space question, the space station is the big coming up decision which will impact budgets. We worry about a decision simply to continue that on the basis of the past. We want it related very carefully to goals that are clearly stated, and worked out, and publicly presented, and get some push behind them, if it's done at all, because otherwise you just put off the decision point. Next year, a lot of people will ask you, "Why are you doing the space station?" The following year, the following year, following year, and each time you'll have pressure not to do it right if you don't get the goals up front.

There is a lot of push I'm shifting away simply from the space station. There's a lot of push to get private funding into the space program, and certainly it should be done whenever it's possible, but I do hope you'll look at it with a careful eye, because it's not so easy to get private funding into this kind of thing as you think. We all look at the great success in communications satellites. They just went through, the industry picked them up, and we soon had profit-making businesses. A lot of the things that are proposed for commercialization are not commercialization, they are done by the private sector, but they're using Government money. So you've got to be very careful in that particular point.

Structure of the space program: We would like to see—and we recommend this—that it be conceived of in two structural components. One is a base program, and a base program which is really a solid one, which does some things of importance and has some nice space successes to its credit but also provides the basis for all other programs, a group of things which we call special initiatives, and in our space thing we would include three things: assured, timely, and economic access to space by a variety of manned and automated launch vehicles. There's a lot of money that could be saved by picking the right launch vehicle in the future. That doesn't mean you can get rid of the space shuttle, as far as we're concerned. The space shuttle has some very important missions in the immediate future, and it may carry the manned space program for a long time. So we would have the space shuttle in there.

A balanced space science and earth-remote sensing: We can accomplish some very important ends with a balanced space science and earth-remote sensing program. And advanced technology R&D to support the current missions, national security specifically. That's been cut in NASA's budget over the years, and we're missing some important technology we could have had had that been supported better.

International partnerships: Some grasp at international partnerships as a straw to save them from drowning. That's the wrong way to do it. People that think that they're going to just leverage our U.S. funding and reducing our vulnerability to budget crises, cuts, that's terrible. There are some important, positive reasons to be in that, because cooperative programs in space are one of the best ways to tie the world together. It's a visible, very active way. We have to recognize that all of these other countries—Japan, China, Western Europe, the Soviet Union—they are becoming space-faring nations and have lots of capabilities, and we have to work with them.

Managing the space program: We have some comments; that's important to us. I make comments in the statement that talks about NASA becoming an aging institution oriented toward short-term, large-scale missions rather than patient, far-reaching campaigns that must be sustained over many decades. I want to apologize for crediting them with all of those things; it's the whole Government of the United States that got them in that boat, and it's very simple that the agreed on programs were never funded sufficiently so that there was all this shifting around.

We would like to redefine diffuse roles of NASA field centers. We'd like to separate space operations from space science and science research and development, and we really would like to coordinate better the civil and defense space programs.

Global environment change: I've talked about that, and the National Academy of Sciences and Engineering also has a white paper on that, and I think—I commend it to your reading beyond the space thing, but it does relate to space as well, because NASA and the space program have a lot to contribute.

Secondly, we also—the academies wrote a science and technology paper, advice to the President, and I think all of the points you've made we make very strongly, and some of us have been involved in that loop, and we know the importance of getting the space—the science and technology advisor of space into a strong position in the administration, because science and technology, far beyond space, have immense implications to our—to the solution of all of our problems, or most of our problems; I can think of some where it doesn't.

In conclusion, Mr. Chairman, the U.S. stands at a new beginning in space. We're going to pick up some of the old things which offer great promise, but we ought to look 30 years ahead and lay out a real program for 30 years, pick the goals and the priorities, and if we have to go slow for a while on something, don't give it up, bring it in at the right time, and so on. But we really have to look at it as a long-term program and nothing that gets reviewed annually and every project gets whacked out. That's a very inefficient way of using our institution and our people.

Thank you very much.

[The prepared statement of Dr. Bodde and Dr. Stever and the report issued by the National Academy of Sciences and the National Academy of Engineering follows:]

Statement of

Dr. H. Guyford Stever
Chairman, Committee on Space Policy
National Academy of Sciences
National Academy of Engineering

Dr. David L. Bodde
Executive Director
Commission on Engineering and Technical Systems
National Research Council

before the
Subcommittee on Space Science and Applications
Committee on Science, Space and Technology
U.S. House of Representatives

February 8, 1989

Mr. Chairman, we are pleased to present your committee with the conclusions of our recent study of U.S. space policy, initiated and sponsored by the National Academy of Sciences and the National Academy of Engineering. In addition, we shall discuss the implications for the space program of two other Academy-sponsored white papers -- one concerning long-term, man-induced changes in the global climate, the other concerning science advice for the President.

Two successful launches of the space shuttle, Discovery and Atlantis, together with a growing fleet of expendable launch vehicles, have restored U.S. access to space. To be sure, much work remains to provide this nation with reliable, cost-effective space transportation. But we have made a good beginning. That beginning, however, begs questions about the end -- about the fundamental U.S. purposes in space. As the Congress once again balances the funding required for a world-leading space program with the imperatives of deficit reduction, the question of goals takes on special importance.

U.S. Goals in Space

The first priority for the Congress and the new Administration is to define our national purpose in space -- to set goals that are specific, imaginative, deserving of widespread public support, and attainable within the realities of a constrained federal budget. This is not a sterile, academic exercise. Clear goals are the framework for clear decisions, and these decisions are needed now -- postponed, they bind policy to ongoing programs; made without national consensus, they would leave large projects like the space station without guidance or support.

The post-Apollo years, when the consensus on space goals dissolved, illustrate this well. Lacking a clear and widely accepted national purpose, the technical and budgetary resources available for space did not match the commitments made, leading to cost overruns, postponed accomplishments in space science and applications, erosion of the nation's space technology base, and eventually a prolonged disruption of American access to space. American goals for space could include a balance of science, global monitoring, and human exploration.

Space Science. A challenging scientific program should be pursued, both as an instrument of U.S. leadership and for the intrinsic knowledge to be gained. It would depend less upon the space station and space shuttle than would other missions. Automated vehicles tend to be more cost-effective for scientific inquiry, although manned vehicles operated for other purposes can nonetheless serve science as well.

Mission to Planet Earth. Expanded observation of the Earth from space will become increasingly important as human activities change the global environment. The challenge is to develop the scientific basis for understanding the rate and consequences of these changes. A series of satellites would monitor terrestrial conditions such as the condition of the ozone layer or the concentration of greenhouse gases. These measurements would be integrated with data from ground stations and aircraft to form a comprehensive data base for understanding and managing our planet's environment.

Human Exploration. The most controversial decisions concern our goals for human activity in space. The will to explore is fundamental to mankind, and manned exploration lends meaning and popular support to much of the rest of the space program. A space station is essential to human exploration for two reasons. First, it must support the biomedical research needed to understand human performance during long periods of microgravity. This includes not only the ability of the human body to adapt to prolonged weightlessness, but also its ability to recover when challenged -- a cut hand, a broken bone, or a drop in air pressure within the vehicle, for example.

Second, the space station must develop the technologies required for such exploration, especially life support and power systems. The current station should be optimized for this research, if human exploration is to be a serious national goal, and the pace of its deployment should mesh well with the pace of that exploration.

The existence of the station presumes, of course, reliable access to it. The current shuttle fleet is marginal for building the station and for using and maintaining it over its designed life. This conclusion holds even with the additional orbiter now under construction. For one thing, the shuttles themselves will wear out, as each launch stresses the orbiter near its design limits. But equally important, disabling accidents (not necessarily catastrophic) must remain a consideration. Even if the probability of avoided accident for each flight were 99 percent, the cumulative likelihood of disabling an orbiter after 6 years at a flight rate of 12 per year would be over 50 percent. Thus, we must count on exceedingly good fortune, or plan to keep production lines openable over the next 15 to 20 years, or develop an alternate transportation system for use beyond the turn of the century.

Balancing Goals and Deficit Reduction. Our choice of goals now will surely commit the pace and direction of America's space program for several decades. The Congress and the President must balance the reach of these goals and the pace at which we seek them with the claims that they will make on the federal budget. The proper balance is a matter of public choice, not technological imperative, and so leadership from the President and the Congress is essential.

Further, we must not delude ourselves that private funding is likely to defray a major part of the cost for the foreseeable future. To be sure, greater efficiency and competence can often be gained from private participation in government-funded activities. This should be encouraged to the greatest extent possible. But it is simply premature to expect the kind of return that would warrant a truly commercial investment. With the exception of telecommunications and possibly earth imaging data, space will remain a government-funded venture. The government must be willing to pay for what it orders.

Structure of the Space Program.

The national effort to realize these goals requires two structural components. The first is a base program, balanced and stable enough to ensure U.S. competence in the essential space activities. We believe a capable base program could be accomplished at an annual budget of approximately $10 billion. The three highest priorities for establishing this fundamental competence should be:

o assured, timely, and economic access to space by a variety of manned and automated launch vehicles;

o a balanced space science and Earth remote sensing program; and,

o advanced technology R&D to support current missions, national security, and specific projects such as the space station.

This base program would provide the fundamental competence to enable success in selected special initiatives, the second component. These large, long-term projects would serve U.S.

scientific, political, cultural, and foreign policy objectives. Examples include the space station, or a program of expanded monitoring of the Earth for environmental and scientific purposes. Each special initiative could require additional funds, probably no less than $1 billion and perhaps reaching $4 billion in peak years. Each would be funded separately from the base program to ensure that operational expediencies do not divert resources from the remainder of the space program. This has occurred in the past, and the consequent erosion of funding has contributed to our now-diminished technology base.

International Partnership.

The core capabilities and one or more special initiatives, taken together, would provide a strong leadership position for the United States in civil space. But we must also recognize the growing capabilities of other spacefaring nations, especially Japan, China, Western Europe, and the Soviet Union. Through cooperative arrangements, the United States might achieve cost savings or gain political or scientific objectives otherwise unobtainable. But, we must have clear and common purposes for such partnerships -- they will no longer work simply as a means of leveraging U.S. funding or reducing vulnerability to budget cuts.

Managing the Space Program.

Demonstrably capable management is also essential. This must begin with NASA itself. NASA has become an aging institution, oriented toward short-term, large-scale missions rather than patient, far-reaching campaigns that must be sustained over many decades. The space agency urgently needs revitalization of its physical plant and human capital. Some of these difficulties could be lessened if the agency were given imaginative, technically challenging, and widely supported missions -- again we emphasize the need for goals. But much of the difficulty is also systemic in character and will require:

o redefinition of the now-diffuse roles of the NASA field centers, with some being considered for private operation to attract and retain the best people;

o separation of space operations from space science, research, and development; and,

o better coordination between the civil and defense space programs, especially in technology development, space infrastructure, and expendable launch vehicles.

Global Environmental Change.

The manifold problems arising from changes in the global environment -- ozone depletion, global warming, tropical deforestation, and acid deposition -- present enormous challenges to engineering, to science, and to the wisdom of political institutions around the world. These challenges arise from the uncertainties in data and scientific understanding that surround these problems and from the magnitude of the response that could be required. A recent white paper prepared for the Presidents of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine suggested three principal strategies.

First, the issue of global environmental change must be given systematic attention within the scientific, political and foreign policy agendas of the United States. Second, greater coordination, both national and international, of the diverse activities related to the problem is required. And third, specific actions, taken now in cooperation with other nations, can deal with those aspects of the problem that are understood:

o for the short term, energy policy should emphasize conservation and less polluting fossil fuels, and in the long term, greater efficiency in energy use and technologies that do not emit greenhouse gases -- nuclear and solar;

o provisions of the Montreal Protocol, a 31-nation pact to limit emissions of chlorofluorocarbons (CFC) signed in the fall of 1987, should be called upon to urge deeper cuts in the production of CFCs;

o the scientific basis for understanding the effects of global warming on agriculture, sea levels, forestry, and water resources must be developed;

o we must develop strategies to mitigate the economic and social forces that underlie the destruction of the tropical rain forests; and,

- we must improve our scientific capacity to predict the future course of the global environment.

Our capabilities in space are particularly relevant to the latter action, and a substantial investment in both terrestrial and space-based monitoring is needed. Thus, this space goal takes on a special importance.

Science and Technology Advice for the President.

A President does not lack advice, solicited or not, scientific or otherwise. But for that very reason, he can benefit from a senior advisor who can cull the proliferation of advice, who recognizes the science and technology components of a policy issue, who knows what analysis can illuminate that issue, and who can identify options for the President. In another white paper, the Presidents of the three Academies suggested the attributes of such a person:

- a commitment to the success of the Presidency he or she serves, and an ability to work in harmony with other senior advisors;
- engineering or scientific credentials sufficient to command the respect of industry, academia, government agencies, and the Congress; and,
- an understanding of the place of science and technology in the policy process.

Appointment of a capable science advisor will be important to the space program. He or she should be a strong participant in selecting the goals that the President will present to the Congress, in ensuring a budget with funds to match these goals, and in assisting the nascent Space Council coordinate the national effort in space.

In Conclusion.

In summary, Mr. Chairman, the United States stands at the beginning of a new era in space. Other nations are moving with measured pace to develop the scientific, technological and, eventually, the commercial potential that space offers. For the United States to participate fully, the Congress and the President must agree on this nation's fundamental purposes in space and the place these purposes hold among competing priorities. Clear goals, fully funded, yet paced for long-term sustainability offer the best hope that our investment in space will generate in the future the benefits it has in the past.

NATIONAL ACADEMY OF SCIENCES
NATIONAL ACADEMY OF ENGINEERING
2101 CONSTITUTION AVENUE
WASHINGTON D C 20418

December 12, 1988

The Honorable George Bush
President-elect
Office of the President-elect
1825 Connecticut Avenue, N.W.
Washington, D.C. 20270

Dear Mr. President-elect:

Early in your Administration, you will be called on to balance the pace and direction of the civil space program with many other claims on the federal budget. The most immediate decisions concern the Space Station. We believe a permanently manned space station is needed to maintain a viable manned space flight capability for the United States. However, its primary justification is to establish the feasibility of human exploration beyond Earth's orbit. For this reason decisions regarding its final configuration, pace of deployment, and place among competing budgetary priorities are best made in the context of your long-term goals for space. Goals that emphasize human exploration, for example, would require that the station be optimized for research on human biology in the space environment.

Building Consensus on Goals

The post-Apollo years saw the consensus on space goals dissolve. The technical and budget resources available for space did not match the commitments made, leading to cost overruns, postponed accomplishments in space science and applications, erosion of the national space technology base, and the prolonged disruption of American access to space.

Thus, long-term, durable, and widely accepted goals for the nation in space are essential, both to sort out priorities within the space program, and also to match the pace and direction of the space program with the larger set of national priorities. Such goals might include automated scientific exploration. They might propose human exploration of the Moon or Mars in the next century, for which a space station is a prerequisite. These goals, established in consultation with the Congress, would provide the stability and consistency that the space program has lacked, and should be an early priority for your civil space policy.

Structure of the Civil Space Program

We believe the national effort to realize your goals requires two structural components. The first is a base program, balanced and stable enough to ensure U.S. competence in the essential space activities. The three highest priorities should be assured access to space by a variety of manned and automated launch vehicles; a balanced space science and Earth remote sensing program; and advanced technology R&D to support current missions, national security, and the goals you set for the future. This could be accomplished at an annual budget of approximately $10 billion.

This core competence would provide the foundation for selected special initiatives, the second component. These large, long-term projects would serve U.S. scientific, political, cultural, and foreign policy objectives. Examples include the space station, or a program of expanded monitoring of the Earth for environmental and scientific purposes. Each special initiative would require an additional $3 billion to $4 billion in peak years. Each would be funded separately from the base program to ensure that operational expediencies do not erode the nation's basic capabilities in space. Decisions on the staging of special initiatives must of course be affordable within the larger set of national priorities.

International Partnership

The core capabilities and one or more special initiatives, taken together, would provide a strong leadership position for the United States in civil space. Equally important, they must take into account the growing capabilities of other spacefaring nations, especially Japan, China, Western Europe, and the Soviet Union. Through cooperative arrangements, the United States might achieve cost savings or gain political or scientific objectives otherwise unobtainable.

Management

Improved management is also essential. This will require

o early appointment of a strong Administrator for the National Aeronautics and Space Administration (NASA), who enjoys your confidence as an adviser;

o redefinition of the now diffuse roles of the NASA field centers, with some being converted to private operation to attract and retain the best people;

o separation of space operations from space science, research, and development; and,

o better coordination of technology development and space infrastructure, including expendable launch vehicles, between the civil and defense space programs.

Private Space Ventures

Finally, the government should use commercial space services where these can be procured at comparable cost and without compromise to legitimate government functions. Your commercial space policy should develop options to stimulate the use of private investment capital. Unclassified technology developed for the space program should be readily available for scientific purposes, commercial ventures, and civil agency use of space.

The Budget Context

We recognize that space must take its place within the larger framework of national priorities. A civil space program aimed at maintaining a respectable position within the growing community of spacefaring nations requires a long-term commitment of significant national resources. But we also believe the nation has received good value for its past investments in space, and that this will be the case for the future.

These points are developed more fully in the following paper "Toward a New Era in Space," prepared at our request by a panel of distinguished scientists and engineers.

Yours sincerely,

Frank Press

Robert M. White
President
National Academy of Engineering

Frank Press
President
National Academy of Sciences

TOWARD A NEW ERA IN SPACE:

Realigning Policies to New Realities

Committee on Space Policy

National Academy of Sciences
National Academy of Engineering

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ACKNOWLEDGMENTS

The U.S. scientists, engineers, and policy experts who shared information and views with the committee during the course of its considerations are too numerous to mention individually. Nevertheless, they made valuable contributions to our thinking. Special thanks are in order for those who spent time with the committee discussing their and our concerns. These include in alphabetical order: The Honorable Edward C. Aldridge, Jr., Colonel Roger G. deKok, Dr. Thomas M. Donahue, Mr. Daniel J. Fink, The Honorable James C. Fletcher, Dr. Jay Goldberg, Dr. Noel W. Hinners, Mr. Dale Myers, Dr. Norine Noonan, Mr. Willis M. Shapley, and Mr. Andrew J. Stofan. The committee also drew on a wealth of past studies and reports, which are listed in the bibliography.

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PREFACE

Decisions made over the next few years will be critical in determining the future of the United States in space. The National Academy of Sciences and the National Academy of Engineering believe that an informed public discussion of these decisions is fundamental to the creation of wise policies. To that end, the Academies assembled a group of experts in science, economics, engineering, and private technology-based enterprise to examine past policies and their consequences and to recommend policies that should guide the national space program over the long term.

Of special concern was the lack of national consensus regarding the long-term goals of the civil space program. This lack of long-range vision has led to the loss of heavy launch capabilities, the fall of the Skylab, and, for lack of alternative launch vehicles, the prolonged absence of the United States from space following the Challenger accident. Without a durable framework to establish priorities, the U.S. space program has promised too much for the resources made available to it. That the National Aeronautics and Space Administration achieved as much as it did under these circumstances is a tribute to the dedication and professionalism of its staff.

The study committee met five times during the summer of 1988. We explored the key components of space leadership and were challenged by the problem of setting priorities in times of severe budgetary constraints. We concluded that major changes are needed in the way the country and its leaders approach national space policy. The committee recognized that the foundation of space policy is its sense of purpose—national goals that are imaginative, durable, and affordable. These goals and the programs to achieve them must recognize the growing capabilities of other nations and, through cooperation, accomplish objectives otherwise unobtainable. The United States cannot expect to be preeminent in all fields of space endeavor, but we must mount a national program to maintain a level of competence in all areas. The committee proceeded to describe the components of a balanced program and to develop the concept of a "base" program that provides a floor of competence and special initiatives—large, ambitious undertakings aimed at major scientific, political, and cultural objectives.

We believe major challenges also provide major opportunities. This paper addresses those near-term decisions that we believe can lead to a fruitful, consistent U.S. space program in the decades to come.

H. Guyford Stever
Chairman

INTRODUCTION

The United States has received remarkable benefits from its space programs over the past thirty years. Our investments in space have enhanced our national security, advanced commerce, furthered scientific research and exploration, and provided critical public services such as weather forecasting and environmental monitoring. Even greater benefits can flow from future space activities if they are guided by clear goals and objectives, adequately funded, and implemented by vital, effective, and efficient institutions.

The full potential of the U.S. space program, however, will not be achieved unless policy changes are made. These changes are needed to align the nation's policies with the new realities that dominate worldwide space activity. These realities include the rapidly growing space capabilities of other nations; the lack of long-term, widely supported, attainable goals that has led the U.S. space program to promise greater performance than its resources enabled it to deliver; the necessary transition away from a period during which the space shuttle held a monopoly on space launches; and protracted constraints on the federal budget.

Many of the benefits from U.S. space activities today flow from the momentum established during the 1960s, when Project Apollo was the centerpiece of a strongly supported national commitment to space preeminence. No similar commitment has emerged since, and the 1986 Challenger accident only emphasized the need to rethink U.S. space policies and programs.

The uncertainties surrounding the U.S. civilian program have become evident at a time when other nations are pursuing vigorous, goal-oriented space programs of their own. In 1969, as American astronauts took the initial steps on the lunar surface, the United States was clearly the preeminent space power, and others looked to it for leadership. This is no longer true. In addition to a continued Soviet commitment to a broadly based space effort, many other countries possess sophisticated technologies and skills with which to pursue their interests in space.

American preeminence in every field of space activity is no longer a realistic option. Even if budgetary resources were available, the scope of space science, applications, and exploratory missions under discussion around the world clearly call for increased international cooperation. Partnerships with other nations and organizations can serve to demonstrate leadership, to forge productive relationships, and to broaden the range of available opportunities, but only if international commitments are made carefully and honored fully. Indeed, the time may be approaching when the old ways of thinking about competition and cooperation must fall behind,

COMMITTEE ON SPACE POLICY

H. Guyford Stever, National Academy of Engineering, Washington, D.C., Chairman

Laurence J. Adams, Consultant. Retired President, Martin Marietta Corporation, Potomac, Maryland

William A. Anders, Senior Executive Vice President, Operations, Textron Inc., Providence, Rhode Island

Arden L. Bement, Jr., Vice President, Technical Resources, TRW Incorporated, Cleveland, Ohio

Joseph V. Charyk, Chairman of the Board, The Charles Stark Draper Laboratory, Inc. and Retired Chairman and CEO, Communications Satellite Corporation (COMSAT), Washington D.C.

Richard N. Cooper, Center for International Affairs, Harvard University, Cambridge, Massachusetts

Robert S. Cooper, President, Atlantic Aerospace Electronics, Greenbelt, Maryland

Edward E. David, Jr., President, EED, Inc., Bedminster, New Jersey

John M. Logsdon, Director, Space Policy Institute, George Washington University, Washington, D.C.

Jeremiah P. Ostriker, Director, Princeton University Observatory, Princeton, New Jersey

Samuel C. Phillips, Retired General, USAF, Palos Verdes Estates, California

Elmer B. Staats, Truman Scholarship Foundation, formerly Comptroller General of the United States, Washington, D.C.

Edward C. Stone, Jr., Vice President for Astronomical Facilities, California Institute of Technology

Staff
David L. Bodde, Executive Director, Commission on Engineering and Technical Systems
JoAnn C. Clayton, Principal Staff Officer
David S. Johnson, Senior Staff Officer
Paul J. Shawcross, Research Associate
Susan R. McCutchen, Administrative Assistant

and large activities will be pursued jointly with many nations to benefit all humanity.

A key problem in U.S. civil space policy is the lack of a widely understood purpose, direction, and time scale for the manned program. In the absence of a consensus regarding such issues, the National Aeronautics and Space Administration (NASA) has achieved only limited success in gaining support for an ambitious program built around a continuing commitment to manned space flight—sometimes at the expense of other important space activities. Faced with expectations that it would provide leadership in all areas, particularly in manned flight, but without adequate funds, the space agency attempted to move ahead on a broad front. The result was a brittle program that could not be sustained over the long term.

The severity of the situation became clear after the Challenger accident, but this recognition also coincided with growing concerns for the federal budget. Faced with spending constraints for all scientific and technological endeavors, the resources required to correct past policy mistakes—especially sole reliance on the space shuttle for access to space—have been diverted from more forward-looking efforts.

Thus, the future direction of the civilian space program will remain uncertain without strong leadership by the President. But this is also a moment of opportunity, when well-conceived policies can propel the United States into a leadership position for the next century. This paper is intended to assist the new Administration in developing the policies, capabilities, and national consensus needed to rebuild a vigorous space program.

THE LEADERSHIP ROLE OF THE PRESIDENT

The civilian space program can be a powerful instrument of national policy. A leading position in space, one that is the result of setting challenging goals and achieving them, reflects the technological capabilities of a nation. Space can provide an international showcase for American technology and for goods and services based on that technology. The challenge of space can motivate many young Americans to excel in engineering and science and can draw high-quality foreign researchers to U.S. universities and laboratories. For these reasons, a purposeful, technically competent U.S. space program should be fully exploited to advance U.S. national interests.

Leadership does not require U.S. preeminence in all space activities, and much can be gained by partnerships with other nations. Leadership does require that the United States be a competent participant in all areas of space activity—national security, applications, science, and exploration—and that it be in the vanguard in those activities most clearly associated with the President's goals for space. Activities involving humans are of particular importance in this context.

This is the arena in which presidential decisions and continuing involvement are required. Without a strong commitment from the President, it is difficult, if not impossible, to gain the broad public support and commitment of resources required to initiate and carry out long-term, necessarily expensive programs. This is because many of the benefits of space leadership—such as national prestige or geopolitical advantage—are long term and intangible. These cannot readily be quantified, even though numerous examples of direct benefits can be found. By contrast, the costs are apparent to all. Thus, steady and affirmative leadership from the President is required to maintain national space priorities within the larger context of the federal budget.

Manned spaceflight is a necessary element of space leadership, a consequence of cultural values and human aspirations to expand beyond the Earth's confines. The space shuttle and space station represent early elements of this expansion. It is crucial, however, that the manned program be so designed that it is not carried out at the expense of other important civilian space activities in technology development, science, and applications and that it can be paced to be affordable on a sustained basis independent of cyclic funding.

Because space leadership is important to U.S. national interests and space is properly a presidential issue, the President should ask the country to support national space goals that are sufficiently imaginative and bold to assert a commitment to space leadership. To give visibility to the importance of his space program, the President must establish his goals early in his Administration. He should then support them strongly with the public and the Congress to help ensure their achievement.

To implement these goals, a formal policy development and coordinating mechanism for the government agencies involved in space activities could be of benefit. But such bodies cannot substitute for presidential leadership and commitment.

As an indication of his commitment to a strong civilian space program, the President should give high priority to recruiting as the new NASA Administrator an individual who shares his goals, who can work effectively with the Congress, and who is widely respected for managerial effectiveness. This individual should be selected as early as possible in the transition process so that he or she will be ready to take charge of the agency when the new Administration takes office. Conversely, delay in filling this position would be demoralizing within the space community and would suggest that this aspect of the national agenda is being given low priority.

TOWARD STABLE BUDGETING: A BALANCED BASE PROGRAM AND SPECIAL INITIATIVES

A civil space program capable of achieving national goals should have two distinct components. The first should be a balanced, stable base program to ensure ongoing U.S. competence in fundamental space activities—for example, astronomical observation, Earth observation missions, microgravity research, planetary exploration that is not a specific precursor to manned missions, space commercialization, tracking and data processing, a robust research infrastructure and its associated human resources, technology development, some space transportation, and some manned space flight. (It would not include major, multibillion dollar programs such as a space station, a return to the Moon, an automated Mars sample return mission, or human missions to Mars.) Within the base, the highest priorities should be assigned to assuring access to space with a variety of launch vehicles; ensuring the availability of advanced technology to maintain a competitive posture in national security and civil undertakings and to enable challenging missions in the future; and building a varied space science and Earth remote sensing applications program. The motivations for this component of the space program are largely scientific, technological, and economic.

Stable funding for this base, or core, effort should be assured before any additional large-scale leadership initiative is undertaken. It must rest on a strong foundation of modern facilities and high-quality human resources. Earlier cuts from the base program to support large initiatives have put the U.S. space program in a position where adequate technology is not available for application to advanced program requirements in such areas as propulsion, life support systems, robotics, or automation.

The second component of the civil space program should consist of large-scale, long-term special initiatives that the President and the Congress decide are in the national interest and for which they seek public support. This component, which would depend heavily on a stable base program, is motivated primarily by political, cultural, and international considerations, although it also may serve scientific and technological purposes. Much of the manned program falls in this category. Clearly, such initiatives should not be undertaken without the commitment to fund and support them adequately over the period necessary for their accomplishment. Since Apollo, NASA has entered into major projects without that commitment and has been forced to either cut back its base programs or compromise on the achievements of the new initiative.

To ensure that primary space capabilities are not eroded by the costs of special initiatives, it is useful to think in terms of a base program with a stable annual budget of about $10 billion (1988 dollars). Each special initiative could require additional funding on the order of $3-4 billion in peak years. (The committee did not undertake a detailed budget analysis, and all estimates are based on existing budget information.) Figure 1 shows historical and current NASA budgets, and Figure 2 illustrates the decline in the NASA portion of the federal budget over time.

The notion of the NASA program consisting of national special initiatives and a base program need not be translated into formally separate budget or organizational terms; it is rather related to the character of the presidential and congressional support required to initiate and carry out the different types of activities. NASA should manage both the base and large special initiatives as a unified whole. The point is that the country's fundamental competence in all areas of space activity should be assured before substantial resources are invested in any major program thrust. When commitment is made to a new special initiative, adequate funding must be provided or it should not be undertaken.

Special Initiatives

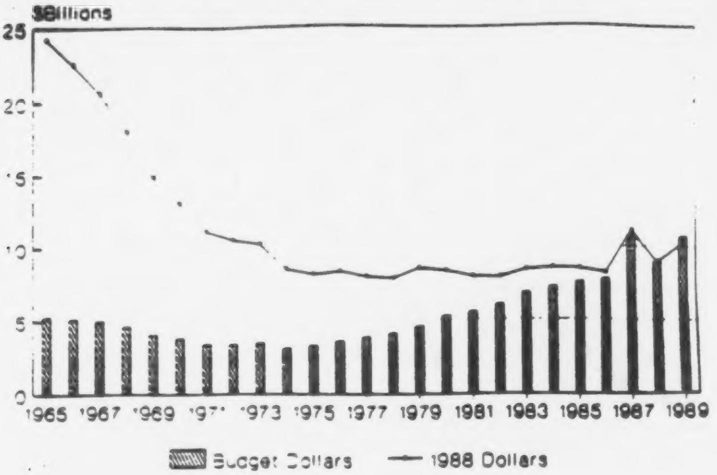
The special initiative requiring immediate decisions is a permanently manned space station, already subscribed to by international partners and well along in its design. The issue is whether or not to proceed with the space station as currently planned. The committee believes that some form of space station is essential to establish the feasibility of extended human space flight. It is the only way properly to research the need for artificial gravity in extended manned missions and to develop the necessary technologies for these missions.

In 1987 a committee of the National Research Council examined the various configurations for a space station that NASA had considered and that others from outside NASA had proposed. The committee found none met the broad requirements of the potential communities of users better than the revised Phase One of the currently planned station.[1] But these requirements are poorly defined, largely due to the lack of widely accepted, long-term goals. To deal with this uncertainty, Phase One of the current station has been made quite flexible, and Phase Two postponed. Nevertheless, the current concept in its entirety will require revalidation to ensure that it fully supports the goals established by the President. Goals that emphasize human exploration, for example, would require that the U.S. space station module be optimized for research in the life sciences.

Finally, the committee noted that the logistic system supporting the station, and particularly, its dependence on the space shuttle, is a principal source of risk. NASA has adopted many of the NRC committee's recommendations, but continued special attention will be required.

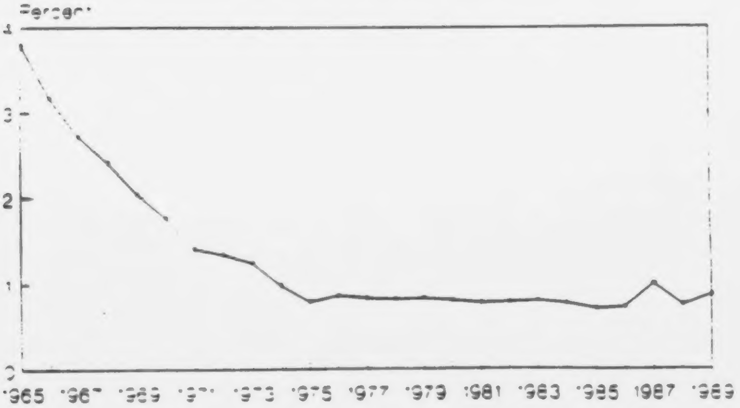
A second possible special initiative is articulated in the Report of the National Commission on Space[2], the Ride Report[3], and in the February 1988 White House space policy statement—the expansion of "human

Figure 1 NASA Appropriations*



*Including DOD Transfers

Figure 2 NASA Budget as
Percent of Federal Budget



presence and activity beyond Earth orbit into the solar system."[4] The schedule for a program leading to human exploration and expansion could be adjusted to budgetary realities and still demonstrate sustained progress that could help build an enduring national consensus in support of the space program. A campaign of this scope could be accomplished at a measured pace over many decades, starting on the space station with the study of the effects of long-duration space flight on animals and humans.

There is substantial disagreement on the specifics of the best plan for human expansion, and in particular whether an outpost or scientific base on the Moon should be established before or at the same time as initial exploratory missions to Mars. Further discussion within both the technical and political communities and between the United States and other spacefaring nations is in order before a commitment to a specific program for human expansion beyond Earth orbit.

Another type of special initiative that would not require substantial in-space human involvement has been termed "Mission to Planet Earth." As conceived, it would be an international multisatellite program to provide simultaneous remote sensing information of all the Earth and predictive models of the global environment in conjunction with ground-based observations. This initiative promises significant near-term rewards in information about the Earth and its environment.

An additional special initiative might be an accelerated program of solar system exploration using automated systems and carried out in collaboration with other spacefaring nations. A Mars sample return mission could be a central part of this initiative.

U.S. special initiatives should be undertaken in consonance with other nations. The Soviet Union, Western Europe, Japan, and China are leaders among many nations that have developed advanced spacefaring capabilities. Through cooperative projects, the United States could achieve technological, financial, and geopolitical benefits that might otherwise be unobtainable. However, the United States must participate in these joint ventures as a reliable partner or not at all.

A principal catalyst for international cooperation can be the International Space Year (ISY), which will begin in 1992. Planning for the ISY is underway in the United States and abroad, but prompt decisions about the nature of U.S. participation are needed if that participation is to be meaningful.

The Base Program

To achieve competance across the board in space endeavors, the base program should include some elements of space infrastructure and the manned program as well as the following: investment in the technical capabilities needed to pursue advanced space programs; a vigorous, balanced space science program; an aggressive civil space applications program; and support for the commercialization of space.

Investment in Technical Capabilities for Advanced Space Programs. In recent years most of the increased investment in space, both in NASA and the Department of Defense (DOD), has supported the development of large systems rather than basic engineering research and technology development. Figure 3 illustrates the long-term decline in research and technology funding, and Figure 4 shows the decline in research and technology as part of the overall NASA budget.

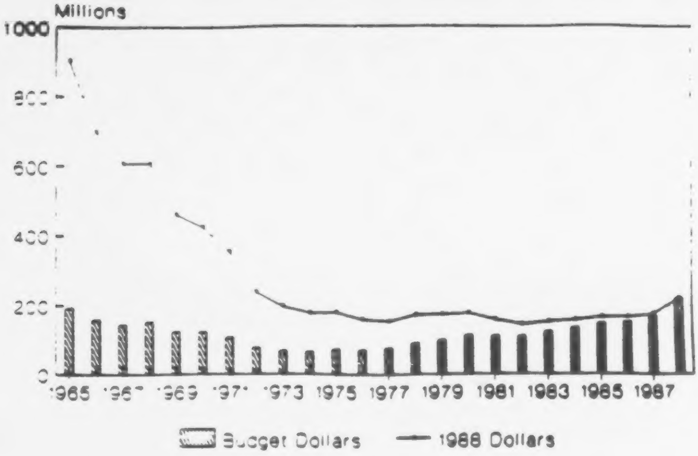
Operational pressures and short-term commitments have contributed to this turn from more basic research. If the United States is to be in the forefront in space, however, it must soon take action to fill the pipeline with the most advanced technologies. Programs designed to enable future missions, such as the Pathfinder and Civil Space Technology Initiative, are steps in the right direction but are not of sufficient magnitude to satisfy future needs for technology.

The need for these investments—in space propulsion, materials, energy systems, sensors, and the technologies to enable long duration undertakings by humans in space—has been described in the 1987 NRC report *Space Technology to Meet Future Needs*.[5] Such a program would be characterized by the following critical elements: (1) stability and continuity of funding to carry out long-term research and development (R&D) in the most effective manner, (2) a strengthened basic research program for generating new options to meeting technology requirements for long-term goals, (3) interagency coordination of program formulation and budgeting stages to enhance synergy and avoid redundant investments, and (4) demonstrations of space technology to establish technical feasibility and to facilitate the creation of competitive technical teams in the private sector working in partnership with NASA to translate advanced technologies into applications.

Finally, NASA must ensure its technology development is carried to a stage where it can be picked up by industry or other government agencies. The nation should invest in technology demonstration to ensure transition of new technologies to industry—as it has with experimental aircraft (X-airplane) programs. Investment should be made selectively in proof-of-concept demonstrations to facilitate technology transition. One way the federal government can help U.S. industry to remain competitive is by advancing technologies that industry is unlikely to undertake because their chances for success seem low, even while their potential payoffs are high. These technologies often require long lead times to mature and the initial investments impose large barriers for individual firms.

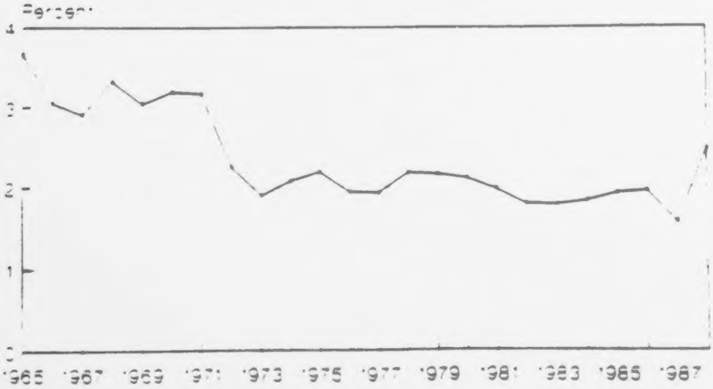
A Balanced Space Science Program. James Van Allen's startling discovery that the Earth is surrounded by regions of intense radiation trapped in the geomagnetic field was the first major success in U.S. space science. Since that unexpected finding thirty years ago, space science has altered our view of the universe, the Solar System, and the Earth and its environment. These discoveries provide a firm basis for a program of continuing leadership in this area.

Figure 3 NASA R&T Funding*



*Excludes Nuclear and Standards and Practices

Figure 4 NASA R&T Funding as a Percentage of NASA Appropriations*



*Excluding Nuclear and Standards and Practices

A challenging space science program should be pursued both as an instrument of U.S. leadership and for the intrinsic knowledge that can be gained. Scientific objectives addressing outstanding, fundamental questions must be the dominant factors in defining the space science program and in determining the characteristics of individual missions such as spacecraft, launch vehicles, and instrumentation.

Space science is a principal objective of the overall space program and one that is best accomplished with a large degree of independence from other major elements of the program. Although the manned program is central to life sciences research and can provide opportunities for other research in areas such as microgravity science, in general the space science program should not be forced, as it has been at times in the past, into a manned mode.

A base program in space science would be designed to increase understanding of astrophysical phenomena and the origin and evolution of the universe; the Earth and the solar-terrestrial environment; the origin and evolution of the Solar System; fundamental physical, chemical, and biological processes; the effects of the space environment on living beings; and the factors governing the origin and spread of life in the universe. Assured, predictable, and frequent access to space is critical to an effective base program. There should be a spectrum of flight opportunities, with major facilities such as the Hubble Space Telescope balanced with increased opportunities on Explorer-class missions and continued availability of low-cost opportunities using aircraft, balloons, rockets, and shuttle-carried experiments.

There also must be a strong program of research and data analysis that sustains intellectual vigor both through the development of the scientific and technical basis for future missions and through detailed study of results from current and past missions. This requires investment in university facilities and educational programs to train the next generation of scientists and engineers. Future national leadership in space will depend critically on the supply of top scientific and engineering talent from our colleges and universities. The education of this talent will require that university investigators have access to space to conduct meaningful experiments and that they be involved in R&D programs and missions at the NASA centers and in industry.

The important elements of a base program in space science have been outlined in the strategy documents prepared by committees of the National Research Council's Space Science Board and in the report of its Astronomy Survey Committee. Many of these elements are incorporated in the 1988 Strategic Plan of NASA's Office of Space Science and Applications.[6]

Possible special initiatives beyond the base program include an automated Mars sample return mission (which is also a logical precursor to a manned Mars mission), space-based interferometry, and a Mission to Planet Earth. These and other challenging major science initiatives described in Space Science in the Twenty-First Century[7] should eventually be considered, but only with the commitment of sufficient additional resources beyond those required for the base program.

The current NASA space science program development and coordination processes work well and should be pursued. Although many of the currently operational U.S. spacecraft continue to return unique results, including observations of Supernova 1987a, the planet Uranus, and the ozone hole, most were launched before 1980 and have completed their primary missions. There is an impressive array of new U.S. missions that will be active through the middle of the next decade due to the backlog of launches delayed from the 1980s. However, U.S. leadership beyond the mid-1990s must take into account the increasing strength of other nations' programs, which have continued to expand and mature. Plans for the next generation of missions should be established to continue the momentum that the United States is expected to regain in the next several years.

An Aggressive Civil Space Applications Program. Communications, navigation, Earth remote sensing, and the use of the microgravity environment to conduct research on materials and processes are the primary applications of space technology for the benefit of society.

In less than three decades the use of satellites for communications has revolutionized global telecommunications. Satellite mobile communications systems and navigation networks hold similar promise for the future. Weather and environmental monitoring, resource location, mapping, and assessment of agricultural productivity and natural disasters are a few benefits of Earth remote sensing. Remote sensing may be key to understanding, and eventually predicting, the consequences of human actions for life on planet Earth. Although the benefits cannot be specified today, space can provide the medium for novel and important research on materials and processes as well.

Each of these applications has unique problems. Since NASA itself is not an end user, NASA's technology development for applications is weak. In communications the current U.S. policy provides for minimal government involvement. Technology research and development are not actively pursued, and government-industry coordination is lacking. Previously, U.S. industry dominated this market by using superior technology; now, other nations are seeking an expanded niche. Competition from fiber optics also can be expected to drive the communications industry toward different types of services, and new technology could be instrumental in assuring future successes.

The diminution of NASA's earlier role in remote sensing research and technology demonstration has left voids that other user agencies have been unable to fill. Thus, the U.S. Geostationary Operational Environmental Satellite (GOES) program is in jeopardy, the transfer of land remote sensing to the private sector is foundering, and there are no firm plans to capitalize on remote sensing of the oceans to meet research and operational needs.

Last, with the lack of space flight opportunities and problems in developing a long-term program, other nations are challenging the United States in microgravity research and applications experiments.

Clear goals are needed to provide long-term, stable commitments to program development and operations that are commensurate with needs and opportunities.

- In space communications, government-industry cooperation in developing advanced technology should be pursued. Affordable, reliable launches are also essential.

- In remote sensing, coordination should be enhanced between government agencies such as the National Oceanic and Atmospheric Administration (NOAA), the DOD, and NASA in technology development and demonstration.[8]

- In microgravity research, as discussed in Industrial Applications of the Microgravity Environment,[9] NASA should play a key role in providing access to the space environment for microgravity research, encourage collaboration between U.S. and foreign microgravity scientists, and maximize multisectoral (industry, university, and government) participation in the program.

Some of the mechanisms described below in the discussion of space commercialization are applicable here as well. Finally, in each area of space applications efforts should be strengthened to assure full cooperation with other nations where such cooperation broadens the technological base in the interest of the United States, reduces cost and technological risks through sharing, or results in equal or better return of benefits to the United States.

Private Capabilities in Space. With the exception of communications satellites and possibly launch vehicles, the development of commercial space activities is far off. Efforts to achieve success will take time and will require partnerships between government and industry. The foremost need for space businesses and entrepreneurs is access to capital and to technology developed by the government. Two principles should guide all aspects of commercial space policy: first, the government should procure private space services wherever feasible; and second, government commitments should be long term and stable.

Specific government actions that would help U.S. industry to compete internationally include

- Continued support for the Air Force family of expendable launch vehicles and their commercial derivatives.

- Use of government owned facilities. Factory tooling, launch facilities, range safety facilities, and down range tracking support during launch represent capital investments that the commercial launch industry cannot afford to provide. These facilities should be made available when their use does not compromise the government mission.

- Commitment to purchase services from the commercial sector. Apart from communications, the largest customer for most space system services is the federal government. With the exception of security requirements and vital public services, the government should not provide its own services if equivalent services are available or can be procured commercially at comparable cost.
- Engineering research and technology development. These are needed to reduce costs and increase reliability in areas of high risk without immediate commercial application and in areas that require long technology maturation lead times. As noted earlier, proof-of-concept demonstrations are sometimes necessary to enable technology transition to industry.
- Indemnity against hazards that cannot reasonably be covered with conventional insurance, perhaps by means of limited third party liability in the event of a launch disaster.

It seems clear that the federal government must continue to be directly involved in supporting and in regulating national efforts and in seeking international fair trade in space-related goods and services for the foreseeable future. Only communications satellites have proven to be true commercial successes; the commercial futures of other space applications and of the commercial launch industry without government involvement appear highly uncertain.

PURPOSEFUL, LONG-TERM MANNED SPACE FLIGHT

The appropriate long-term reason for putting humans into space remains an area of continuing controversy. Given the costs of a manned space flight program, and its role as the most visible segment of the U.S. space effort, the committee believes that the next Administration should address the rationale for a continued manned program directly, recognizing that there are significant disagreements among thoughtful individuals on this question. Some call for commitment now to a bold program of human exploration and expansion beyond the vicinity of Earth. Others believe that the emphasis should be on discovering the capabilities of humans as permanent residents in Earth orbit and the impact on crews of living and working in the space environment. Still others believe that a large program of manned space flight activity should be postponed in favor of other space activities with more immediate scientific and economic benefits, particularly because a manned program would require a large commitment of U.S. scientific and technological resources, substantial government funding in quest of returns that are largely intangible, and political support that may not be forthcoming.

Although there are situations in which human involvement as an operator of space systems is justified, the most sustainable rationale for today's manned space program is related to the research and technology development activities that are necessary precursors to any decision to commit the United States to sending humans to Mars for initial exploration or back to the Moon for extended stays. Humanity's aspiration to explore other worlds, and perhaps eventually to expand human presence and activity beyond the immediate vicinity of Earth, provides a vision that gives meaning to current activities involving humans in space. To pursue this aspiration, an orbital laboratory—a space station—and a focused life sciences program are essential. Giving primary emphasis to life science and technology development activities, linked to long-term human exploration and expansion, in plans for utilizing a space station provides a long-term focus for that effort. The ultimate decision to undertake further voyages of human exploration and to begin the process of expanding human activities into the solar system must be based on nontechnical factors, and this is appropriately the province of the political process. There is, however, a clear need for substantial scientific and technological research to provide a foundation on which such a decision can be intelligently made. Given human aspirations and technical capabilities, it is difficult to deny that some men and women will eventually live and work on other celestial bodies. For many visionaries, the question becomes what role, if any, the United States wishes to play in humanity's quest to become a multiplanet species.

The committee accepts as a reasonable answer to this question a plan that focuses for the next decade or more (1) on a space station as a facility for learning how humans fare in extended-duration space flight and for developing the technological capabilities for deep-space human exploration, and (2) on developing the space transportation capabilities to support such a station. Although this kind of plan implies a reorientation in the primary rationale for the space station and a rethinking of plans for outfitting and utilizing it, it may not require major shifts in the current design. Whether such changes would be necessary will depend on the review of the station based on the space goals of the President.

Properly aligned with these goals, the space station program would become a national special initiative, with presidential and congressional commitment to its purposes and to a funding level above that of the base NASA program. This would imply NASA budgets in the $13-15 billion range during the first half of the 1990s.

SPACE INFRASTRUCTURE

The Congressional Budget Office report, The NASA Program in the 1990s and Beyond,[10] points out that the planned NASA program for the next decade has as its primary aim putting in place an infrastructure designed to support a variety of space missions, including many that are ambitious in scope and that have not yet been approved. Before the country invests in such an infrastructure, there needs to be assurance that it is well matched to future missions and to continuing space activities that are likely to be approved and carried out. Many of those missions and activities would be part of the special initiatives described earlier.

The most important element of the space infrastructure is the capacity to launch payloads into orbit. The country is slowly recovering from the crucial and expensive policy mistake of depending on one system for its access to space. The transition to a diverse, robust, and resilient launch capability is underway but will take a number of years to complete. The Air Force has taken the lead in this process by ordering upgraded versions of the Delta, Atlas, and Titan expendable launch vehicles (ELVs) for most of its space transportation needs, and by planning to use the space shuttle only when its unique capabilities are required. NASA is not as far along in this transition, and its plans for the immediate future still call for primary dependence on the shuttle. In this period, the emerging commercial ELV capacity is treated by NASA as a backup, even when expendable vehicles could meet mission requirements, for example for launching planetary missions. A constraint on NASA's ability to diversify is the additional cost of ELVs, but NASA and Congress should make ELV procurement a high budgetary priority, especially where ELVs are needed to support base programs and capabilities.

For future launch systems, NASA and DOD should continue to work together on requirements and technology development. The key desiderata for these advanced launch systems are reliability (because payloads are costly to lose), a capacity for rapid processing (to ensure the timeliness of launches), low cost (allowing access to space for a wider community of users), and diversity and redundancy (so that failure of one element of the launch infrastructure does not shut down the nation's entire launch capability).

The development of commercial launch vehicles and supporting facilities can be an important contribution to the U.S. space infrastructure. Indeed, the reentry of the Air Force into the ELV market has enabled U.S. companies to open their production lines for commercial launchers. This, together with the policies described in the previous section, can help U.S. industry compete. Nevertheless, U.S. launchers face intense competition from foreign enterprises, which often enjoy government support and can charge prices that do not reflect total enterprise costs. In addition, the worldwide overcapacity in launches will make it difficult for private companies to compete without some form of government participation. At issue is the extent of such assistance and whether it should be supplemented by prohibitions on the use of foreign launch vehicles by U.S. users of space.

There is a natural tension between the users of space and the commercial purveyors of launch vehicles and services. For the users, inhibitions against the use of foreign launch vehicles are not desirable because they would increase the cost of access to space. In the view of the committee such restraints should not be imposed, except where national security considerations take precedence. In the absence of restraints, however, the President should commission an interagency review of the national support required for a private U.S. industrial launch capability. This group should recommend to the President whether alternative support should be implemented.

With regard to the shuttle, NASA's plans for launching each vehicle three to four times a year appear optimistic, given the uncertainties surrounding the return of the shuttle to routine flight operations under demanding new procedures and safety requirements. Further in the future, the sole dependence on the shuttle for resupplying the space station has the potential of repeating the mistake of depending on a single system for any critical task. A more productive policy would be to husband the shuttle as a valuable resource with a limited life and to depend on unmanned launch vehicles unless the presence of humans is essential. To give resilience to the program and to provide for contingencies, access to the station by ELVs is highly desirable. A crew emergency rescue vehicle is essential.

The nation has underinvested in advanced technologies related to space transportation systems; this situation must be remedied if intelligent future choices are to be possible. Technologies such as advanced propulsion, lightweight materials, and miniaturization, along with nondestructive testing and cost reducing techniques, need greater emphasis. A decision on when the United States needs a heavy lift capability or other new manned or unmanned space transportation system must depend on choices of future space missions, but NASA should aggressively develop the technologies needed to enable such decisions.

The currently planned space station program, a key element of an in-orbit space infrastructure, is intended to support a variety of uses. Emphasis on microgravity research as a major station justification has not provided a strong political or scientific foundation for the program. By contrast, an aspiration to extend human presence and exploration beyond the near vicinity of Earth would require understanding the impacts on humans of long-duration exposure to reduced gravity. If such a goal is chosen by the President, the U.S. portion of the space station should be optimized to perform research in life sciences such as space biology and medicine in preparation for future long-duration manned missions. Although this would represent a policy shift away from the previous emphasis on manufacturing in space, a significant amount of microgravity research would still be possible in the European and Japanese modules, where room has been provided for U.S. experiments by agreements signed with these nations. A dedicated U.S. module, a free-flying laboratory, or additional on-board shuttle facilities could be added later if needs for additional microgravity research develop.

Other aspects of the planned space infrastructure, such as orbital maneuvering and transfer vehicles, upper stages for deep space missions, and tracking and data relay satellites should be carefully and continually evaluated in the context of both NASA's base program of science and applications missions and those special initiatives that are actually pursued. In short, the nation must avoid investing in unneeded capabilities while ensuring the availability of the capabilities required for mission success.

A STREAMLINED, AND REVITALIZED, NASA

NASA is still able to attract capable young people to its work force and retains a base of skilled, highly motivated individuals eager to take on challenging new missions. But it is also an aging institution, with an urgent need for physical and human revitalization. The agency has shown an organizational culture resistant to change and oriented strongly to carrying out large-scale, highly visible, relatively short-term missions, rather than far-reaching campaigns that must be sustained over decades. Many doubt the present capability of the institution to carry out the important missions of the future. Some of NASA's institutional problems could be diminished if the agency is given a mandate for carrying out bold, imaginative, and technically challenging missions. But other problems are systemic in character and must be addressed directly. Sustaining an organization capable of excellence in carrying out programs that may take decades to complete requires innovative management approaches.

To reinvigorate the space agency, the committee believes it will be necessary to strengthen Headquarters' management capabilities, redefine the roles and missions of the NASA field centers and make adjustments as needed, examine conversion of field centers to semiautonomous status, and separate NASA's development and operational capabilities.

Strengthen Headquarters Management Capabilities

Although steps have been taken in recent years to address some of NASA's institutional problems, the agency has had great difficulty in attracting and retaining people of experience and capability into Washington for Headquarters positions, a situation due in part to competition with private industry, noncompetitive civil service salary levels, and restrictions on employment after leaving government. This has led to major weaknesses in program management, institutional management, and conduct of external affairs, all areas in which the Headquarters must be strong and competent to be effective in leading the centers and managing the affairs of the agency. This is a general government problem that will require legislative relief from some federal civil service regulations. NASA should have flexibility in hiring and personnel advancement similar to that recently given the National Institute of Standards and Technology to help deal with the issue of noncompetitive salary levels.

Reassign Field Center Roles and Missions

Within NASA, research and technology development is administered largely by the Headquarters Office of Aeronautics and Space Technology (OAST). OAST directs three NASA research centers: Langley, Lewis, and Ames. These centers were the core of NASA's predecessor, the National Advisory Committee for Aeronautics, where they played distinct technology development roles. When NASA was chartered in 1958, additional centers were created to meet mission needs for the space program.

After the Apollo program, as budgets declined, the NASA centers sought new areas of employment. This has resulted in diffusion and blurring of the roles and missions of the centers until the focus of activity in most program areas has been greatly diminished, leading to duplication of physical and personnel resources and skills and increased overhead costs.

The specific roles and missions of the various field centers should be reassessed. A study should be undertaken of these roles and missions with the objective of refocusing efforts and realigning projects with appropriate centers. Changes should be evolutionary and executed over a period of several years.

Give Semiautonomous Status to Field Centers

NASA programs are beginning to suffer because of retirement of skilled people and the difficulties in replacing them and in training and retaining qualified new scientists and engineers. Many facilities at the NASA field centers need rehabilitation as well.

To be competitive from a personnel point of view, NASA needs relief from the civil service limitations it now bears. The Jet Propulsion Laboratory is recognized as an outstanding NASA center. Much of its strength derives from its status as a federally funded research and development center that is operated by a private university and thus able to offer competitive benefits to its personnel.

Converting other NASA centers into government owned, privately operated institutions would afford them a degree of autonomy similar to that of the Jet Propulsion Laboratory, Lincoln Laboratory, or the National Center for Atmospheric Research and would provide them flexibility to hire and retain outstanding people by offering more attractive salaries—without increasing overall expenditures. However, any attempt at such conversion should be thoughtfully planned to ensure that commitments can be kept and research is not disrupted. Initially, such actions might only be taken at a single center. The experience gained in due course could be applied to other centers. An attempt should be made to associate each center with at least one first-rank technical university, private laboratory, or industrial laboratory and to negotiate facility renovation, when necessary, as part of the conversion process.

Separate Development and Operational Capabilities

NASA's current organization does not distinguish between those responsible for developing new systems and those responsible for long-term continuing operation of existing systems such as the space shuttle. There is concern that NASA may become so consumed by operational matters that the bulk of its resources will be increasingly devoted to operations to the detriment of NASA's primary function, namely to develop new space systems in support of continued space research in science, applications, and exploration.

The term "operational" as applied to commercial aircraft, ships, or mass-produced defense equipment probably will never apply to space systems in the same context. However, large complex space systems such as the shuttle and the space station are, or will be, driven largely by operations issues—turnaround time between flights, manifesting, or retrofitting of design changes for reasons of safety, cost, payload capability, logistics, and training of crew members. These are not the basic work of research and development leading to new concepts and ideas for future space systems nor for expanding knowledge of the universe and discerning the implications of that knowledge for life on this planet and elsewhere.

There should be within NASA an organization for space flight operations that is separated from developmental activities. Two types of expertise are involved, and it is important that people working in flight operations recognize that as their job and be committed to excellence in its execution. It is equally important that people working in space systems research, development, and program management have the same recognition and commitment and that their activities be separated from engineering maintenance and other operational tasks.

NATIONAL SECURITY AND CIVIL SPACE: THE NEED FOR HARMONY

Although the nation has reaped many benefits from its civil space program, a strong national security space program (intelligence and defense) is fundamental to the welfare of the country. While this paper has focused almost exclusively on civil space policies, defense uses of space can and should both draw on and reinforce the civil program. This is especially relevant because defense and security expenditures for space are now substantially more than civil expenditures. However, neither program receives the full measure of benefit that would derive from closer cooperation between the two.

Relations between the civil space program and national security space activities as envisioned in the 1958 Space Act were to be close and cooperative. The DOD was to benefit from space research and development carried out by NASA, and, under properly controlled circumstances, technology could also flow in the other direction. Cooperation was generally satisfactory up to the point that the shuttle became a divisive issue, but in more recent times the relationship has been particularly strained, due largely to each agency's perception of its mission. Yet, critical areas of mutual interest remain—common, dual-use technologies; launch vehicles; and launch facilities.

The situation clearly demands more effective liaison between the agencies. NASA needs a high-level person who reports directly to the Administrator to serve effectively as liaison with the DOD. This person should have a strong background in DOD space matters. Waiver of government regulations regarding restrictions on retirement pay should be made if necessary to attract the right individual.

Strong, cooperative programs, particularly in space engineering research, and better liaison between the two agencies would strengthen the national security space program, lend new vitality to civil efforts, and enable the country to receive the maximum benefit from its investments in space. Technical coordination also serves to communicate the existence of new technology, and joint efforts among the players could enable greater accomplishment. Wide awareness of the degree of coordination and of the total national effort will enable the rational assignment of budget priorities. Such coordination has been accomplished effectively in the past—the X-15 program is a salient example. Currently, space power provides another. The Defense Advanced Research Projects Agency, Department of Energy, and NASA/OAST together have undertaken expensive research into the use of nuclear energy in the SP100 program, research that neither agency would be likely to undertake alone.

Last, the direct merger of civil and defense assets offers the potential for improved efficiency and economy. However, each case is unique and requires thoughtful analysis prior to action. In the area of meteorology both NOAA and the Air Force have run operational meteorological satellite systems in polar orbit for more than twenty-five years. Over time, the two programs have tended toward becoming more complementary. They now use the same basic satellite "bus" and back each other up in case of a loss of in-orbit assets. In the past, foreign policy concerns have been the basis for rejecting a converged system managed by the DOD. In these times of extraordinary pressure on the federal budget, however, this issue should be revisited. By negotiating joint DOD/NOAA management and satisfactory arrangements with international partners, significant savings could be achieved.

Other areas with apparent potential for such efficiency gains include oceanographic and geodetic satellites and launch services. With regard to launch services, the current joint study of an advanced launch system by the Air Force and NASA is a welcome development.

SUMMARY AND CONCLUSIONS

The successful launch of the space shuttle Discovery on September 29, 1988, restored the U.S. capacity for manned spaceflight and reopened an important avenue to space. These restored capabilities, however, raise questions regarding their use—what are the U.S. purposes in space, and how can we best achieve them in a time of protracted constraints on federal spending?

These questions require early, yet thoughtful, resolution. Early, because postponed decisions tend to bind policy to ongoing programs, such as the current space station, that become increasingly costly to alter. Thoughtful, because choices made now will shape the capabilities of the United States in space for many decades and will affect commitments to our closest allies. These decisions are a matter of public choice, not technological imperative, and so presidential leadership is essential.

Decisions Regarding Goals

The most important space decisions the new President must make concern the nation's goals. These must be sufficiently bold to maintain the United States as a leading spacefaring nation, yet paced to be achievable within a constrained budget.

The most controversial decisions concern our goals for human activity in space. The will to explore is a fundamental trait of mankind, and the aspiration to extend human presence beyond the Earth's orbit will lend meaning and support to many aspects of the space program. But human exploration requires a strong scientific and technological foundation. This foundation should be strengthened before it can sustain long-duration exploratory missions.

Finally, U.S. space goals should take into account the rapid progress in space science and technology made by the Soviet Union, Western Europe, China, and Japan. Through cooperative projects, the United States might achieve technological, financial, and political advantages otherwise unattainable. This nation, however, must participate as a reliable partner or not at all.

Decisions Regarding Methods

To accomplish these goals, the President must select an Administrator for NASA who shares his vision and can work effectively with the Congress to bring it about. This should be an early priority. Interagency policy setting and coordinating mechanisms might be useful, but these cannot substitute for a strong Administrator who enjoys the President's confidence.

NASA itself must be revitalized. This will require stronger management capabilities in the Headquarters and redefinition of the now diffuse missions of the field centers. Some centers should be privately operated to ensure their ability to attract and retain technically qualified people. Space operations should be managed separately from space science, research, and development.

Decisions Regarding Programs

A civil space program capable of achieving national goals should have two distinct components. The first should be a balanced, stable base program to ensure U.S. competence in key areas of space activity, resting on a strong foundation of modern facilities and high quality human resources. The second component should consist of large, long-term special initiatives serving U.S. political, cultural, and foreign policy interests and proposed by the President with congressional support.

The space station, which has been the object of much study and for which international agreements have been signed, is one such special initiative and will require an early decision by the new Administration. The committee believes a station is essential to establish the feasibility of human exploration beyond the Earth's orbit and to develop the necessary technologies. However, final decisions regarding the configuration of such a station should await the President's decisions regarding goals. Goals that emphasize human exploration, for example, would require that the U.S. space station module be optimized for research in life sciences. Later, potential special initiatives might include an automated Mars sample return mission, a return of humans to the Moon, or a trip on to Mars.

A basic technical competence in space activity is essential to ensure effective use of the resources invested in the special initiatives, and a capable space infrastructure is essential for both the base program and special initiatives. Launch vehicles and services must be reliable, diverse, and affordable. There should also be closer coordination between the civil space program and the defense space program to make better use of common technology and infrastructure.

Decisions Regarding Budget Priorities

The current NASA budget of $10-11 billion provides for a base program and the early stage of one special initiative, a manned space station.

The three highest priorities in the base program should be assured access to space by a variety of launch vehicles, advanced technology development to support national security and civil undertakings and to enable challenging missions in the future, and a varied space science and Earth remote sensing program. A more ambitious base program would also include a vigorous space applications program and support for space commercialization.

Beyond the base program, far-reaching presidential goals for science or human exploration would necessarily lead to one or more special initiatives, recognizing that each could be expected to add approximately $3 billion to the NASA budget in years of peak expenditures. With a space station among these, the current budget would need to grow to approximately $14 billion to meet the peak spending years of the station, without reflecting any other growth in the NASA program.

In summary, the new President has a historic opportunity to create a space program that will continue and expand the role of the United States as a leading spacefaring nation. In the committee's judgment the decisions described above are essential to realizing that opportunity.

ENDNOTES

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Mr. **Nelson**. Dr. Stever is a part of that most prestigious group of scientists here in this city, the National Academy of Sciences, from which one of their panels is called the National Research Council, and it's in his capacity as chairman of one of their committees on space policy that he comes here today to us. He comes here with a long history of being a distinguished scientist, and, if I recall, you were the science advisor to President Nixon, were you not?

Dr. **Stever**. And President Ford.

Mr. **Nelson**. Well, then, you are eminently qualified to answer the first question.

Dr. **Stever**. But can I make one correction?

Mr. **Nelson**. Please.

Dr. **Stever**. Mr. Ford, in the White House, it was the science and technology advisor to the President.

Mr. **Nelson**. I see.

Dr. **Stever**. Before, it was the science advisor, and some of your predecessors in this Congress worked hard to get the law and everything to change that direction of that position.

Mr. **Nelson**. Well, why don't you just tell us. Why is that important, and why is it important to have a major emphasis by the President upon his science and technology advisor?

Dr. **Stever**. For many reasons. I'll list—I once wrote a paper for Mr. Ford, and I sent the draft to him, and he only corrected one sentence—I was very proud of that—in the publication, and he said at the end as one of the justifications one sentence: "If he doesn't have good science advice right at his hand, he'll make mistakes," and I thought that was a great thing. That's part of it, to help him avoid pitfalls that are bound to happen.

But more important, science and technology—and I think of this as a great spectrum of activity from basic research through applied research to the applications in industry, in medicine, and so on—those things—that area becomes ever more powerful in the affairs of man, for good and for evil, by the way, and it's important that considerations of that field be brought in early and consistently in handling governmental affairs, and that's why we think he should have a man and an organization right at his fingertips.

There's coordination problems, there are—well, there are—the business of advice; the President does not lack for advice; advice is pouring on him, scientific and other advice. He needs somebody to winnow it, and pick it out, and so on. I think it's an important position, and our academies think it's a very important position. I think the whole science and technology community does, and we have co-opted industry into that and a lot of other people.

Mr. **Nelson**. Thank you, Dr. Stever.

Mr. Sensenbrenner.

Mr. **Sensenbrenner**. Yes. Thank you very much, Mr. Chairman.

Looking at the evolution of the space program over the last 30 to 32 years, it seemed to me that we had the strongest public support for the space program when President Kennedy gave his very visionary statement that he intended to send a man to the moon by the end of the decade of the 1960's, and Congress and the public backed him up, and even after his tragic death the appropriations were still there and we did land a man on the moon before the end of the decade of the 1960's.

Since that time, we really have not had a consensus on space goals, and to what do you attribute this lack of consensus?

Dr. **Stever**. Let's start with Kennedy. We had a terrible shock in this country with respect to our scientific, technological, industrial capability, and our Government in general when the Soviets launched a space satellite and then a man in space, and we had to prove ourselves.

I remember giving lots of speeches in those days, and the audiences were scared that we were becoming a second-class technological society, and the military especially. We wanted to prove ourselves, and we did with that program, and we were all very proud of it, and it had a lot of momentum to continue, but with the other elements—the problems that Government had, it really began suddenly to take a second place. We had to work out what the continuance was.

There was a transition period there that maybe lasted too long. We dropped off, in any case, and probably we made a mistake; I guess I would say more than probably. In hindsight, we made a mistake. Most of us didn't know it was a mistake at that time, putting all of our eggs in the shuttle basket, but has proven to give us some difficulties, and when the accident came—and, by the way, most people had dropped off even reading the newspapers about a shuttle launch by then.

When the accident came, we went from a position in which we thought NASA could do anything, absolutely anything, in space it wanted to do to a position in which they couldn't do anything. NASA was neither that great in the beginning nor that bad in the end, and they've fought their way back beautifully.

But this is now a mature field, 30 years. We've had lots of successes. We'll continue to have lots of successes. Space won't go away, but some elements of space it's going to be harder to sell, especially in a tight budget. So we have to face a different future, and I think we ought to do it by getting our goals straight, getting our priorities straight, and going for it in an aggressive program within that.

Mr. **Sensenbrenner**. My friends in the political management business tell me repeatedly that the way you get your message across is with the 40-second sound bite, and if you can't make your point in 40 seconds the editor in the newsroom will use his scissors to cut and paste and will probably garble up what your point is.

Dr. **Stever**. I stand corrected.

Mr. **Sensenbrenner**. With that in mind, if you were President of the United States, trying to rally public support for a long-range space goal that this Nation can commit itself to, how would you say it? And you have 40 seconds.

Dr. **Stever**. I would—I personally would support one of our so-called extraordinary programs that are more above our base program. But I caution you, if you don't support a good space program you're going to be—base program, you're going to be in trouble in the future. That's our attitude; it's my attitude.

Mr. **Sensenbrenner**. Okay. Your time is up, and so is mine.

Mr. **Stallings** [presiding]. Mr. Schiff.

Mr. SCHIFF. Dr. Stever, I'd like to ask just about one thing. First, may I introduce myself. My name is Steven Schiff—just joined the committee and the subcommittee and the Congress here recently.

In your presentation, you—if I understood you correctly—sort of downplayed the idea of international cooperation as a means of economic approach to space research. I thought I heard you downplaying it as a way of leveraging American dollars and so forth. It may be just because I'm a freshman, but I thought that was kind of a neat idea to maybe invite some of our technologically and economically equipped allies to have a greater share in the space program. So it didn't seem that the American taxpayer, in view of the deficit, had to bear so much. Did I understand you correctly, or did I not?

Dr. STEVER. I'm sorry that I had to talk off the cuff instead of reading some decent words. Of course we think international partnerships are very important; we just don't want people to be fooled that they're going to cost less because they're international. We may share the cost. I think they'll actually cost more, because I have watched international organizations work together and try to do something.

On the other hand, if there are four nations supporting a program which costs twice as much and they share it equally, why, obviously, the cost to any one of them is half the program. In that sense, it's good. Now that's also an exaggeration. But the most important thing is, they get us international recognition. It's a good technique of bringing the countries of the world together. That's why I think it's important, not so much for trying to save money, which often isn't saved.

Mr. SCHIFF. One other question. Again, it's kind of a freshman question. I'm sure that it's been asked here before. But the budget is the ongoing subject, at least as I've heard, on economic matters on Capitol Hill, and yet we're proposing more money for the space station, which you've mentioned. How serious of a problem do you think it would be for the country if the Congress were to decide that, in view of the budget deficit, we just can't appropriate money for the space station this year? What would happen if that occurred, in your judgment?

Dr. STEVER. There would be a lot of shifting, shifting and hauling. It would be disastrous, I think, if it said go to zero. But I have a feeling that you could cut it down some, and you may be able to cut some—try to do some elements of the base program a little better. But if you were to cut out any of those, why, I think you're in trouble.

Mr. SCHIFF. Thank you, Dr. Stever.

Thank you, Mr. Chairman.

Mr. NELSON. Mr. Smith.

Mr. SMITH OF NEW HAMPSHIRE. Thank you.

Mr. SMITH OF TEXAS. Dr. Stever, like other members—

Dr. STEVER. Oh, there are two Mr. Smiths.

Mr. NELSON. There are two Mr. Smiths. Excuse me. Mr. Smith of New Hampshire.

Mr. SMITH OF TEXAS. We knew that this was going to be a problem.

Mr. **Smith of New Hampshire**. If we get a couple more, we are going to elect the Speaker, Mr. Chairman.

Two questions. I agree with your analysis, obviously——and I think we all do here on the committee—of the long-term goals, Dr. Stever, but, to be candid, we've heard it before. We've heard it from the administrations, and we've also heard it from the scientists and the people in NASA, frankly. But, really, nothing has come of it. How do we set these goals?

I realize we can say, in the pure sense, the President has got to set the goals, but you and I both know that that's more symbolic than actual. Somebody has got to do it; somebody has got to get down in the trenches and do that. How do we do it?

Dr. **Stever**. Well, one thing you could do is talk about goals and priorities. You could shorten the—you could lengthen the authorization and appropriation thing so we'd know; we would begin to work at things rather than just fumble into new things all the time.

Mr. **Smith of New Hampshire**. The people who have been in, at least in the four and a half years or so that I've been on the committee—the people who've been in here from NASA—and I think my colleagues will back me up on this—there is a large amount of infighting within the agency and within the scientific community, and within NASA in general, on, you know—between the pure scientists, the earth monitors, and the human exploration, you know, who ought to get the priorities. So I think it's fair to say that you haven't had your act together either, not meaning you personally.

But I mean those within the agency and within the scientific community really haven't been—there's a lot of infighting. Nobody has presented—there has been no evolution or an attempt, really, to evolve a policy where everybody could say, "I'm satisfied; I'm a scientist, and I'm satisfied with the pure science aspect of it." You know, take what you want; take the top of the line; you want the best. Here's what I could have in the best case scenario. Even in that case, we can't get agreement, and I don't think you're going to be able to hold the administration, or any administration, accountable if you don't get that. I think it's got to be a combination of both. I think we all know that, but I don't think we know how to do it, and I'd like—if you could offer it—I realize it might be a little bit out of your realm, but I certainly would like to hear it, as to how we might get the attention of the President.

Dr. **Stever**. First, I want to thank you because you described our community as a human community and our institutions as human institutions, and I'm afraid that's true of all of the institutions and individuals that ever come to you with programs.

Yes, we have lots of disagreements. I have a feeling that if—if the budget were cut, if you wanted to cut an amount equal to the space station out of the budget as a suggestion, a lot of people pick that as the first thing to cut because a lot of people are just plain against manned space flight and would prefer not to do it, would prefer to use space as a place where we develop robotry.

But if you are forced to cut our budget, I think you can ask the leaders of NASA to come up with a proposal to save as many of our long-term goals or to put some of them on a slower burner. I urge you to ensure, however, they don't give up some of the base ideas which are going to permit us to do things in the future.

Do you want me to come and give you a specific thing to cut out of the budget?

Mr. SMITH OF NEW HAMPSHIRE. No.

Dr. STEVER. No.

Mr. SMITH OF NEW HAMPSHIRE. No. I think we're back, though, in the same trap. I don't think, whether you have a one-year budget authorization, a two-year budget authorization, a five-year budget authorization, that's really not—it would help. But where are we going?

You mentioned a 30-year goal. I agree with you. I'd like to reach out beyond that. You know, one of the groups out there that supports this space program more—perhaps more enthusiastically than any other is the school kids. It's incredible. At the elementary level, I've spoken, as a member of this committee—I've spoken to schools throughout my district; I've seen the NASA people come in to my district, and the kids are absolutely motivated. They know more about it than they get credit for. Obviously, you've got to sell that. But I think you've got to go out.

Let me pin it down here. The problem is that we say you need a two-year authorization, a three-year authorization. We can plug it in here—and that's our job on this committee to do that—if we know the whole picture, but there is no whole picture. I think the chairman of this committee knows what he would like, and I think the committee pretty much knows what we'd like to see for the whole picture, but we're not getting that, and until we get it, you can't ask us to cut something, support something, if we don't know what we're cutting, we don't know what we're supporting.

I have heard it over and over again in here, and I've heard it privately conveyed to me from some members of both the science community as well as NASA, "Well, we've got to—you know, there's too darned many manned—the space station, there's too much money on the space station; we want to study Mars; we want to do this." There is a tremendous amount of jealousy and competition and infighting, and unless that act comes together we're not going to go anywhere with the space program.

Dr. STEVER. I would like to do at least one thing that might help you. Our committee certainly puts the space station as the next major thing, a big spender, and does not say, "Go to Mars," and so on. We would—that would come later.

Mr. SMITH OF NEW HAMPSHIRE. Well, your base program comments are excellent. I support that. I think that's a start. That's where we ought to start.

Dr. STEVER. And if the budget is larger than that, then we think the space station is next. I believe that's a correct thing.

Mr. SMITH OF NEW HAMPSHIRE. Well, I think that's the kind of thing we need to hear, and I think that's the kind of thing you need to tell, if you will, to the administration.

Dr. STEVER. Yes, sir. I think in our report we make it very clear that the space station is next on the big items. You can increase—if your colleagues say we've got to go to improve our knowledge about the global environment, that can be increased for less money, by the way, than I think that the space station would require.

Mr. **Smith of New Hampshire.** It's nice to say balance—we need to balance so much here, so much there, for this program or that program, but what happens is, when something is projected for a cut, there's usually a lot of yelling about it, but nowhere do we see where it fits in in the overall priorities down the road if, in fact, we do have to cut something, and we may have to. We may have to look back.

Dr. **Stever.** Well, I think we just gave you at least one of our priorities about what the next big thing is, if you have enough money in the budget to support something and you feel—who was it who said or, I guess, asked me about how I would get the world excited about things, have something reasonably spectacular. I think the space station would be a spectacular kind of thing. If somebody wanted to send a man to Mars, that would be more spectacular, but I wouldn't bet on it at this stage of our knowledge.

Mr. **Smith of New Hampshire.** One final comment, Mr. Chairman. I know it has been used over and over again, and it is somewhat trite, but the comments that were made in 1961 by President Kennedy when he said, "We will place a man on the moon," that was a goal, it was a clear goal, it was a ten-year goal, and everybody worked to fill in the slots, and I don't see or hear that kind of a commitment from anybody, perhaps other than the chairman of this committee, anywhere in the national leadership either at NASA or from the White House or anywhere else, and I think that's what we need. You don't have to say we have to have a man on Mars by such-and-such a year, but you've got to lay out what you want to do, and then let's fill in the slots and support it with the appropriate budgetary matters, and if we can't, then we indicate that, and then we begin to prioritize and work from there.

Dr. **Stever.** I agree with you.

Mr. **Smith of New Hampshire.** I don't think we're doing it, and I'm not saying it's your fault; I like what you have to say; I just hope they can implement what you've said.

Mr. **Nelson.** Just on what Bob Smith said, why don't you share with us your ideas of the importance of setting that goal, regardless of the budgetary constraints?

Dr. **Stever.** I think space is sufficiently important in the long-term future of this country that we should, very much so, absolutely. If we could have a goal right there in front of us, a long-term, serious goal, and then we said—and then we put some priorities on it but we didn't wipe out the goals as we went along, we kept them there, I would like that very much. But, you see, goals and priorities go together. You just have to work those together.

Mr. **Nelson.** It's a part of budgetary setting priorities when you set goals.

Dr. **Stever.** That's right.

Mr. **Nelson.** Because then you go—you let the driver in the equation be the goal, not necessarily the dollar.

Dr. **Stever.** Exactly. You change the time at which you achieve some of the goals. And, by the way, there'd be a lot of practical decisions along the line. You've got a cooperative agreement with somebody that you want to follow through even though you may decide that that wasn't the best thing to have done, and there are a lot of practical things that'll shift these things around, but if you have the goals there at least you've got a road map.

Mr. **Nelson**. Exactly.

Mr. Lewis.

Mr. **Lewis**. Dr. Stever, what is wrong with looking at the plan that we have and, as Mr. Smith is pointing out, that we establish within that plan the priorities, regardless of what the budget constraints are, and work from that direction?

Dr. **Stever**. Do you mean the plan—

Mr. **Lewis**. Can the industry do that?

Dr. **Stever**. The NASA budget one?

Mr. **Lewis**. The one you referred to in your opening comments about last year's plan, it had no priorities.

Dr. **Stever**. I think that that document has most of the goals that you could possibly have, and its one problem is, and the problem we face is, that it hasn't got priorities set to it, set priorities and timing.

Mr. **Lewis**. What would it take now to establish the priorities for that goal-setting plan, as proposed by NASA?

Dr. **Stever**. Well, I think it's—this is the administration. Well, NASA would help you on that, I think; I hate to promise.

Mr. **Lewis**. It's going to take more than NASA. I think Mr. Smith pointed that out. The industry itself has to be part of, and a complete part of, the priority establishment in order to fill the slots to meet the goals. You see, I have a difference between priorities and goals. You can set the goal, but you have to set your priorities in order to reach that goal.

Dr. **Stever**. That's right, and I think that it has to start with the administration and the budget that is handed to you, because the budget is a priority statement.

Dr. **Bodde**. Mr. Lewis, this illustrates the point made earlier by our chairman that a presidential science advisor who has the confidence of the President is one of the strong assets in forming such goals, as is a strong head of NASA who also has that confidence of the President, and taken together these can be powerful assets in linking goals together in a national campaign, and in linking priorities together, and in being able to say yes to some things and, by implication then, no to other things.

Dr. **Stever**. And the Space Commission, and the Office of Management and Budget, and the President, and have it sent up here, and you people work it over with that kind of approach, and see what we get.

Mr. **Lewis**. Do you have an input to NASA and to the proposed plans that they have? Did you have input into the proposal that they came up with last year?

Dr. **Stever**. Last year's proposal?

Mr. **Lewis**. Yes, last year's plan.

Dr. **Stever**. I was not involved in that. I was working on helping NASA get the shuttle reactivated, but I was not involved in their planning.

Mr. **Lewis**. In your judgment, Dr. Stever, what do you think it would take, looking at the goal-setting plan proposed by NASA last year to establish those priorities using the administration, and who else would have to be part of those priority settings?

Dr. **Stever**. I personally think we need—as the chairman has said, we need a strong head of NASA, and we need a science and technology advisor, and that's a good beginning in this administration. We need that now, and presumably they will get in touch with the industrial community and the scientific community, and so on, and do what governments are supposed to do—hammer out compromises and good aggressive programs within compromises.

Mr. **Lewis**. Okay. Now let's say that all takes place. Let's say that the science advisor, the head of NASA, the administration, through their efforts, comes up with a plan. Would you and the industry work together, whether you agreed or disagreed with all the plan, to establish the priorities to meet those goals?

Dr. **Stever**. Well, I think we have to.

Mr. **Lewis**. Well, they don't do—that doesn't happen now. You say, "We think it would happen," but I don't think it happens now.

Dr. **Stever**. Well, you mean would we keep quiet about the fact that we didn't agree with those things? We would work within them, but we might disagree. You can never shut up individuals or institutions, but you can get them working on the right kind of thing.

Mr. **Lewis**. No, but I have great concern—and I think Mr. Smith was alluding to this—that if a plan would be established and the industry discredits it sufficiently, they also—we also lose the support of the public in many areas.

Dr. **Stever**. I agree with that very much.

Mr. **Lewis**. You don't agree with that?

Dr. **Stever**. I agree with it.

Mr. **Lewis**. Oh.

Dr. **Stever**. I agree with it.

Mr. **Lewis**. Well, how do we eliminate that? I think that's the number one goal that we have to set on this committee and one of the priorities that we have to establish if we're ever going to get from here to there.

Dr. **Stever**. Well, I think you have to tell people that that's what's happening.

You know, it's an interesting thing. You talk as if we in science have a nice group of people coming up with a program. When this report was published, some of my very close friends called me and said they would appear as witnesses here and disagree with me 100 percent, and I don't think we're going to suppress those differences of opinions. But the fact of the matter is, the space program is not the opinions coming and going, it's what you actually have budgeted, and who's doing it, and what you're doing. That's what you have to aim for, and people will soon learn that that's what they should be working for.

Mr. **Lewis**. Well, as one who was part of the scientific community for almost 17 years, I agree with you and I disagree with you. I still feel that—the chairman pointed out that we come forward, and so did Mr. Smith a few minutes ago, with the goals and establish the priorities and forget the budget, absolutely forget the budget, and if we can get a consensus from the scientific community and the industry in those areas, then we should start applying budgetary figures, because the priorities would establish for us where the money has to be spent. As it is right now, it's almost like a grab basket.

Dr. **Stever**. Yes, but it may be impossible to separate them completely, because they're both going on at the same time. But if you're consciously doing one and doing the other and bringing together—as you're separating the grab basket while it's being developed, you're just describing the political process of putting a budget together, and it's just as hard here as it is elsewhere. But I don't think—

Mr. **Lewis**. Do you think it's insurmountable?

Dr. **Stever**. Pardon?

Mr. **Lewis**. Do you think it's insurmountable? Do you think we can do it?

Dr. **Stever**. Oh, no. I think you're doing fine.

Mr. **Lewis**. You think we're doing fine right now?

Dr. **Stever**. Keep at it.

Mr. **Lewis**. I think we're doing poorly.

Dr. **Stever**. Well, you've won a lot—

Mr. **Lewis**. My own personal opinion.

Dr. **Stever**. You've won a lot of battles over 30 years. This has been a great program in space. I want to tell you, you look back on it, and you just can't help but be proud.

Mr. **Lewis**. I'm not disputing that, I'm just disputing where we're going and where we're coming up with the plan in order to meet our far-flung goals when many of us are not even going to be here to witness them when they're accomplished.

Dr. **Stever**. Well, Winston Churchill said it: Never give up.

Mr. **Lewis**. I have one other area—one other question I'd like to ask, Mr. Chairman, about the—you did point out, and I have to agree with you completely, our success in space science has been outstanding. I would like to know, in your opinion, have we been devoting enough of the space budget to space science overall, and, if not, what do you think can be done in order to do that? Can it be made a hybrid into other programs?

Dr. **Stever**. Yes, in two or three steps. First of all, we have a backlog. As I said, if we get rid of that backlog of launches on the shuttle, we will have done a great deal for several fields of science.

Secondly, we have to realize that we have not begun enough unmanned planetary exploration things. We ought to begin that process and get some in the pipeline. They're not going to be flown for another eight to ten years or something. We should get them in the pipeline and start. I think that's a very important thing for us to do.

So, you know, all is not lost there. I think we can step into that with relative ease. If we get those unmanned—the ELV launchers, we're going to be able to do a lot more in that planetary exploration, and those ELV's are in the base program we talked about.

Dr. **Lewis**. Very good. Thank you, Dr. Stever.

Thank you, Mr. Chairman.

Mr. **Nelson**. You know, we missed a great opportunity in the Tom Paine Commission, the National Commission on Space, and it was their job to be very visionary and look to the future, and they had just about come out with their report when Challenger was destroyed, and a lot of the impact of that Paine report was lost, although it's an excellent report.

What would be your recommendation to us to be visionary, to talk about what ought to be, and set some goals for the next 50 years in this country, and then establish those goals and go?

Dr. STEVER. There are a lot of people that still would work with you on the visionary goals and so on. There are a lot of other people who say it's too expensive, and you would have to reconcile as you go along those two things, but I think that I would encourage you to have other goal-setting programs.

Another thing, I think we have to restore faith in the NASA program by having a whole series of successful shuttle launches of these scientific missions and the military missions and the missions to get your infrastructure, like TDRS and some things on Project Earth, or Program Earth—what is it?

Mr. NELSON. Mission to Planet Earth.

Dr. STEVER. Mission to Planet Earth. I think it is a long, uphill battle, but we should face it.

Mr. NELSON. Mr. Volkmer.

Mr. VOLKMER. Thank you, Mr. Chairman.

I do have some things here, and I find a statement in your—a part of your statement that supports some of the concerns that I have. We've been hearing a lot of discussion that's been going on on visionary goals. You know, some of us, and I think many of us, already have a short-time goal we're finding it more and more difficult to achieve. That's taking up a lot of my time.

Dr. STEVER. It certainly is.

Mr. VOLKMER. The space station, to me, is a goal. Is it not?

Dr. STEVER. Well, it's a goal and a program.

Mr. VOLKMER. Right, but to me it's a goal to achieve.

Dr. STEVER. Yes, it is.

Mr. VOLKMER. In our efforts in space. And to get there, we'd have to have certain methodologies of doing it, and one of those things that we have to have is, make sure that we have an SST fleet that's going to be capable of doing that.

Dr. STEVER. That's right.

Mr. VOLKMER. And you point out in here, on page 4, "Thus, we must count on exceedingly good fortune, or plan to keep production lines openable over the next 15 to 20 years, or develop an alternate transportation system for use beyond the turn of the century."

There's no question from our discussions with Mr. Fletcher that at this time we're not going to have an alternative method, at least for the next short term, and I'm talking about, again, the beginning of that space station and for a few years afterwards. So let's say for the next 11 years, at least to the turn of the century, we're going to be relying on that shuttle.

That being the case, it wouldn't be very wise for us—and I think I know the answer from your previous statement—for us just to shut down that whole line that we have and say we're going to go with the three we have plus the one orbiter that's being built, and we're never going to have an accident, or nothing is ever going to happen to a wing or a tail assembly or to anything else.

Dr. STEVER. No. I think NASA is better equipped than I am or we are to give you the details on that, but I agree with your general point.

If you take the solid propellant rockets that are needed in the current shuttle, they can be improved and developed to more reliable devices with time if you aren't going for an advanced solid rocket motor. The shuttle vehicles, if we require more of them in the future, they, too, can be improved, although they really kind of depend upon a lot of outmoded technology at the present time, and in that improvement you would want to jump into some new technology as you went along. But I do think NASA is the one to give you the details of how that's done, but I agree that this is an important principle.

Let me make one statement. You said the space station is a goal.

Mr. VOLKMER. Yes.

Dr. STEVER. We think of it as a stepping stone to much longer-range goals.

Mr. VOLKMER. I won't deny that. I won't deny that. It's a goal to reach other things, right.

Dr. STEVER. An intermediate goal.

Mr. VOLKMER. But let's say I don't get to that first one.

Dr. STEVER. Then you're not going to get to the second one.

Mr. VOLKMER. It's like the child. If you've never taken your first step, you're never going to walk.

Dr. STEVER. I agree.

Mr. VOLKMER. How am I going to get—and get back to, let's say, to the moon for human habitat if I don't have that space station and if I have to take off from here on the earth to do that? If I want to make a manned trip to Mars, isn't it going to be a lot better and easier to start off in low earth orbit than it is to start off from here?

Dr. STEVER. Well, that again is something that's going to be studied, as to whether that's the take-off place. We think of the space station as being the research and development prelude to either of the things you're talking about.

Mr. VOLKMER. I won't argue that, but can not it be developed to where it would be the base station?

Dr. STEVER. You mean and a take-off point?

Mr. VOLKMER. Yes, as a take-off point.

Dr. STEVER. Well, there are some people who think it is and some people who think they'd rather go the other way, and that was the same argument, by the way, that your predecessors had to face with respect to going to the moon: should we go directly, or should we orbit the earth and then orbit the moon before we got there. The orbiters won, and I'm pleased they did because it was very successful.

Mr. VOLKMER. All right.

Thank you very much, Mr. Chairman—I just want to make a statement. To me, yes, there are long-range goals within my mind, but right now I feel that I've got to reach that first goal before I can get to those other goals.

Dr. STEVER. And I think NASA agrees with you.

Mr. NELSON. Mr. Smith of Texas.

Mr. SMITH OF TEXAS. Thank you, Mr. Chairman.

I find myself in agreement with virtually everything that my colleagues have said with regard to goal setting. My only suggestion—and I'd like to ask a question after making a statement—is that I do think we need to give more attention to public sentiment, because I think public sentiment will enable us to do our job better. If we have that public support, we're going to get more money for the programs, we're going to have more confidence in moving forward as we should.

The vice chairman of this subcommittee mentioned a while ago the idea of condensing one of your responses into 40 seconds because that was about the average length of some TV bites. That was probably a generous giving of seconds, because I read recently that the average TV bite given to the presidential candidates in this last election was nine seconds, but I think we can move it up to some extent, the point being that you do have to be able to sell it to the public and you have to be able to sell it to the public in a very kind of short, summarized fashion.

I think it was President Abraham Lincoln that once said that public opinion is everything, and if we ever forgot that as a Congress we were reminded of that yesterday on another issue. But I think the lesson is one that we could probably use to our own advantage and apply it to the space program.

So I would simply say to my colleagues that I hope we will give that more attention, the idea of harnessing public enthusiasm, channeling it in the proper direction, and using that to help the program lift off into the future.

My question is this, and I speak here as a neophyte when it comes to space policy, but just in the period of the last seven days I've read articles, editorials, columns, and so forth both talking about the great spinoffs, the technological spinoffs, of the space industry, and I've read conflicting reports saying that, in effect, if we were interested in spinoffs we'd be spending our money better on pure research and development and not worry about the space program.

So I was going to ask you just how important the spinoffs really are relative to the space program, or is that part of the PR that I've been talking about? Are they significantly important? Is it something that we should be emphasizing or, relatively speaking, are they not important and should we forget about the spinoffs and just go forward with the programs themselves?

Dr. **Stever**. Well, I think there have been some spinoffs which are important. I think people, when they're claiming credit for spinoffs, tend to exaggerate, and this is on both sides; the people who are doing the research tend to exaggerate, as well as the people who are doing particular space programs. But I think that some of our industries were strengthened by the space program and there were good ideas that came out of it. I have a feeling that unless we do some new things, why, we may be on the down part of the curve. That's why I'd like to see the advanced technology program in the base program of NASA's work.

I do think that we should keep hammering away on the subject of spinoffs, but be careful that you aren't presenting a picture that can be—on each one of them that isn't accurate and a good one.

By the way, that's just—some of you must sit on the—do sit on the science and technology committee, and I want to say that when the basic research programs that you support come up, people ask, "What's the spinoff?" and it's always very difficult to show what it is, but there is some there, and you have to work to dig it out.

Mr. SMITH OF TEXAS. So basically your answer is, neither one side nor the other, some spinoff—

Dr. STEVER. Oh, I think—yes, that's a big argument. A lot of people that say there are no spinoffs are really just against the space program for other reasons and therefore would like to knock that down. But no one can claim all of the credit for spinoffs, the basic researchers, or the applied researchers, or the space people, but they're all contributors.

Mr. SMITH OF TEXAS. No Mr. Chairman, I don't have any other questions. Thank you.

Mr. NELSON. Mr. Buechner.

Mr. BUECHNER. In the cover letter that we received with the report, I find the reading of it to be a little confusing to me. The paragraph one seems to attempt to plant some further delays in the space station. It raises a question about the configuration and the pace of deployment as a requirement for further alignment with new national space goals, but the body of the report—i.e., pages 5 and 15—describe the space station as quite flexible and that even a reorientation and primary rationale requirements may not require shifts in the current design, and, further, even the NRC, an arm of the NAS, reviewed the configuration and couldn't find a better configuration.

Now I'd like to know how you explain the difference of opinion between Mr. Press, the NAS report, and the earlier NRC report.

Dr. STEVER. Mr. Chairman, you reminded me of an old professor. When he wrote his thesis, he put on about page 166 a line, "If anyone reads this line on this report, I will give them a bottle of champagne." No one ever came. You get my bottle of champagne.

Mr. BUECHNER. I don't know if I can accept that.

[Laughter.]

Dr. STEVER. It'll be a cheap champagne.

But let me try to face that. We recognize that those two statements were slightly different. The statement in the body of this report is the statement of the committee which I chaired, and I am representing them today. The covering letter is a letter prepared by the vice—the president, Academy of Science, Academy of Engineering. They did want to throw a little different accent on this. We've tried to reconcile them. We don't think they're quite as far apart as you would like. I think that the president's statement in the covering letter would apply very strongly if the budget pressure knocked NASA down this year. We—our group think—I guess had a feeling that—that you would be dealing with the space station budget probably before you could master changes.

Secondly, the Academy, under those two presidents, actually put out a report a couple of years ago that they couldn't see a better configuration for the space station than the one that is here.

I would make one other point. Our committee believes that the space station should be more strongly configured for manned space flight exploration than I think NASA now is doing, although they're shifting a little. We have that difference, and I think that the two presidents felt that until those differences in opinion were settled we should hold off on the space station—settle it before we started off. I think there is a difference, and you're correct. I cannot get rid of the differences in my own community.

Mr. BUECHNER. And it sends out mixed signals, obviously.

Dr. STEVER. It certainly does.

Mr. BUECHNER. And I think that perhaps—certainly we've served the purpose here that we show that one has—there is a bias against that is articulated in the cover letter.

Dr. STEVER. I actually think that there is a slight difference there in that thing. But the two presidents were not against the space station; they just said, "Let's get the act together before you proceed with it."

Mr. BUECHNER. Well, you know, one of the things in that cover letter also, they talk about the benefits of international cooperation, and we've got signed space agreements with the Europeans, Japanese, and Canadians, and I would just venture that, at this point in time, to go jerking around with the configuration wouldn't make them exactly happy campers. Is that a fair statement?

Dr. STEVER. I think not. But let's take that as an example of international cooperation, to make something. We'll be paying $30 billion over a number of years for that space station, and those people will each be contributing—what?—a billion dollars, of that order. It's not—they got an awful good bargain. If you're really going to have an international program like the space station, maybe we should have them contribute a third.

Mr. BUECHNER. Well, I'm not sure whether—with the current mania about technology fleeting away, I'm not sure whether you're going to get this Congress to agree to exactly that type of a partnership. We always seem to—we start off to be the general partner and end up being the limited partner.

But I think, once again, that the high tone about international partnerships, that configuration does happen to be at this point in time relatively established, at least in the minds of those partners, and that good partners, whether you don't think—if we're not getting enough bang for our buck from them, it's a little late to rewrite that contract, and I just say that I think it's another—it, in a way, is almost self-serving to talk about the high-toned idea of international partnership and then turn around and want to ax part of what is already in agreement, and that is configuration.

Mr. VOLKMER. Would the gentleman yield?

Mr. BUECHNER. Certainly.

Mr. VOLKMER. I remember back when this was first brought up about the international cooperation, and I think there was a general consensus that if we asked the Europeans to put up a third and the Japanese to put up a third and we'd put up a third, we wouldn't very well just have the ability to run the show. Do you understand what I mean? Right now, the program the way it is, we generally run the show, they're coming along for the ride, and I think everybody recognizes that.

Dr. STEVER. You're putting your finger on it precisely. We want to run things.

Mr. VOLKMER. Yes.

Mr. **Buechner**. If I can reclaim my time, I guess a question we have to ask you is, would a shuttle C be a better way to assemble the space station in terms of cost-effectiveness?

Dr. **Stever**. I have to say—I have to confess ignorance. I would like to see it explored much more completely, but I do think NASA is going to have to explore cost-effective ways of erecting a space station, and whether that's it or not I wouldn't say.

Mr. **Buechner**. I thank you very much, and I appreciate your candor.

Mr. Chairman.

Mr. **Nelson**. You have given us a lot to look forward to. You've also debunked one of the interpretations of your report that we always thought to be inaccurate, which was that you guys were coming out four square against the space station. You haven't said that at all, and you've made it very clear. What you're saying is, you're not minimizing at all your priorities for science in our space program, but you're saying that that is one means to one goal if you're going to have a manned exploration goal of the solar system.

Dr. **Stever**. That's right.

Mr. **Nelson**. So we appreciate you clarifying that.

Also, you make me want to be in the all-powerful decision-making position where I could go and create another national commission on space and that we could go out and redo in part what the Paine Commission had done and say, "These are the goals," and then formulate that in the decision-making process into a policy, and that the policy was going to set these goals, and I think that's part of the excitement for the Bush administration to carry through on and what we're going to urge and encourage and where we can, from this vantage point of a committee, provide information for that goal setting. So you have stimulated us, Dr. Stever, and we appreciate it very much.

Dr. **Stever**. Thank you.

Mr. **Nelson**. Thank you, Dr. Bodde, for accompanying him, and let me ask the next panel to please come up.

Mr. Morrison, we welcome you. We're delighted to have you, and you all have done a major study for the transition team, the space policy study. You were the project director working under the Center for Strategic and International Studies. Accompanying him are Dean Acheson, Gil Rye, and Charlie Walker.

Mr. **Morrison**. Mr. Chairman, a slight correction: David Acheson.

Mr. **Nelson**. Oh, I'm sorry. Did I say—I said "Dean Acheson." No wonder.

Mr. **Morrison**. I'm sure Mr. Acheson takes no offense, as a reference to his father.

Mr. **Acheson**. Nor is it the first time, Mr. Chairman.

Mr. **Nelson**. Mr. Secretary of State, we're delighted to have you. Is he your father?

Mr. **Acheson**. Yes.

Mr. **Nelson**. Is he really?

Well, I tell you, he was a big deal when I was in college. Let me tell you, I'll never forget, at my graduation, he was leading the procession, and we had the same alma mater, and that was a big deal for us. But that was a few years ago.

Well, we welcome all of you.

Now, I take it, Gil and Charlie, you were part of the study as well.

Mr. **Rye**. Yes.

Mr. **Nelson**. Okay. Well, we're looking forward to it, so let me turn to you, Mr. Morrison.

STATEMENTS OF JAMES MORRISON, PROJECT DIRECTOR, SPACE POLICY STUDY, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES, WASHINGTON, D.C.; DAVID C. ACHESON, SENIOR CONSULTANT, SPACE POLICY STUDY, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES; GILBERT RYE, VICE PRESIDENT AND GENERAL MANAGER, SPACE SYSTEMS AND TECHNOLOGY, BDM INTERNATIONAL, INC., MCLEAN, VIRGINIA; AND CHARLES D. WALKER, SPECIAL ASSISTANT TO THE PRESIDENT, MCDONNELL DOUGLAS SPACE SYSTEMS COMPANY, ARLINGTON, VIRGINIA

Mr. **Morrison**. Thank you, Mr. Chairman.

I would like to note that the National Academy of Sciences needs no introduction in this forum, but perhaps the Center for Strategic and International Studies does, since this is the first time that CSIS has briefed this subcommittee on space matters.

The Center for Strategic and International Studies is a research organization founded in 1962 to foster scholarship and public awareness of emerging national and international issues on a broad, interdisciplinary basis. It is bipartisan and nonprofit. Its areas of research are selected in consultation with its governing bodies, and its work is entirely unclassified.

One other report that made considerable news recently, just this past week, and which was jointly sponsored by CSIS and the Johns Hopkins Foreign Policy Institute, related to modernizing land-based strategic missiles, and I think most people here would recognize that.

In late 1987, CSIS established a steering committee for this civil space policy study under the then cochairmanship of Brent Scowcroft and John McElroy. Mr. Scowcroft is not with us now, as he was taken from us by President Bush when he was nominated to be President Bush's National Security Advisor. I regret that John McElroy could not be with us today due to an unavoidable conflict. I believe he is defending the academic ranking and salaries of the faculty in his engineering department at the University of Texas at Arlington. I think we would recognize that's a fairly important objective, and we wish him well in his efforts.

Nevertheless, Mr. Chairman, I am honored to be sitting here before you this afternoon in the company of three gentlemen who reflect the very high quality of the experts who have participated in our study, and if I read you their biographies it would take the rest of the afternoon. However, just a very brief sketch.

David Acheson, who is a senior consultant to the study, a renowned lawyer, member of the presidential commission on the space shuttle Challenger accident in 1986 and senior vice president and general counsel for the Communications Satellite Corporation from 1967 to 1974. Mr. Acheson led the effort on our study to develop a white paper on the subject of why is the civil space program important on the national agenda.

Gil Rye, who is known to you, is presently senior vice president for space systems and technology at the BDM Corporation. Prior to that time, he was on the National Security Council as the director of space and intelligence programs at the White House from 1982 to 1985. We could not possibly think of a better person to chair our Government Organization Working Group.

Charlie Walker, also known to you, is a Special Assistant to the President of McDonnell Douglas Space Systems Company for Space Programs Development. He was the first non-career, industry-sponsored astronaut serving as a payload specialist on three space shuttle missions, 1984/1985. Again, we could not possibly have picked a better person to chair our Commercialization Working Group.

If I could turn to substance for a moment, I think it is encouraging. You have just heard from the briefing by Dr. Stever that there are many, many areas of similarity between the National Academy study and our own. While there are differences, the main point is that the two studies reinforce each other considerably, and for a new administration coming in, it would be one matter if the National Academy advised them to go left and we advised them to go right and everybody would say, "What the heck is going on here?" It is not that way. We are not one for one with each other, but we are very close.

I'm very sorry Mr. Sensenbrenner has left, because I'd like to address briefly the subject of national objectives. We did address this as a major part of our study. Two of our objectives are almost identical to those of the National Academy. The first is the environment. It's a program, it's a mission, it's a problem whose time has come, and the space program can make many contributions to it.

The second very similar objective is in exploration. The National Academy's words are emphasis on "human exploration". We changed that slightly and say "solar system exploration," but including a very strong human component to do that. I don't believe the Academy would argue with us.

Two other national objectives that we would emphasize are, first, education. President Bush has indicated that he, in his new budget coming up, he wants to set aside some money for improving education in mathematics and science. That isn't the only problem. Mr. Lauro Cavazos, the Secretary of Education, has indicated that if young people at the age of the third grade do not turn on to science subjects they're unlikely to do so afterwards, there's a motivation problem, and we argue that there's probably no other single program that can help to motivate the young people of the United States than a strong civil space program.

We also argue strongly for competitiveness. The New York Times had an article just the other morning, a lead editorial, that the U.S. space program should devote itself to competitiveness. We also think it's important, but it is not the sole objective by any means at all. In addition, the civil space program contributes strongly to foreign policy and national security of the United States Government.

Turning to organization, there were some successes under the SIG-Space/Space Commercialization Working Group system, which the Reagan administration had, but there were major lapses also. The progress was perhaps best personified by the policy that came out early last year, the January and February policy statements. But there were also major lapses, such as after the Challenger accident.

The conclusion of our study was, in general, that "committees can coordinate but they cannot lead", and "coordination is important but it is not sufficient", and the major emphasis that we made on the organization side is, for heavens' sakes, you now have a multi-agency civil space program; put somebody in charge, not a committee; put somebody in charge; and Mr. Rye will be able to speak eloquently to that in a moment.

On the commercialization side, we wished to return to first principles, since the experts that our committee dealt with over the past year came down all over the map. You can get people to advise you in any direction on space commercialization. Therefore, our committee—and I'll only mention a couple of the first principles that we went back to. The first is, space commercialization is an important investment in America's future. The second one is that ultimately only private capital can bring space technology to bear on such national objectives as improving America's competitiveness and balance of trade, only the private sector.

We see two principal policy dangers at the present time. One is in overselling what commercialization can do, at least in the short term, and, on the other side, in not supporting commercialization strongly enough, and, in fact, many Government agencies fall on one side or the other of that equation. Promising areas of commercialization must be identified and evaluated realistically and pursued with determination.

With this in mind, the principal conclusion that we reached on the commercialization side is that the Bush administration should act rapidly to establish a task force with congressional and private sector representation to develop specific recommendations on commercialization within six months to get the administration's act together, and hopefully there would be a four—at least a four-year period of consistent policy to work from.

On the program priorities side, I'll not dwell on it. We think the environment is very high priority. CSIS found no controversy from any quarter about whether NASA should mount the Mission to Plant Earth. We do recommend that. We do recommend that the Bush administration adopt as a long-term goal emphasis on long-term goals, exploration of the solar system, including a human component, Humans to Mars. Dr. Stever has dealt with science. We would also say that the applications programs—thinking of American competitiveness, that an applications plan should be put together very similar to the excellent plan that NASA has developed in the sciences. We need something comparable in applications to make sure that, across the board, this is a very strong program.

In launch vehicles, we agree with Dr. Stever that reliable and cost-effective access to space is the sine qua non for success in all aspects of the space program, and therefore we recommend that one of the first actions of the new Space Council be to establish a commission with representation from Government and the private sector to develop and provide to the Congress within one year a national space launch program covering a 20- to 30-year horizon. If the Space Council stepped up to that multi-agency, including the private sector, enormous problem, it would help us enormously. Launch vehicles is not an area that the U.S. has done well with in the past. In space—particularly in a competitiveness—from a competitiveness viewpoint.

We endorse very strongly the words of my predecessor up here on supporting space technology. That, again, supports competitiveness and our ability to do advance programs in the future. And, finally, we also believe that something that this committee—subcommittee is into, which is multi-year funding of projects, is extremely important for the future of the program.

Mr. Chairman, we are still in process with our study. We anticipate that a final report will be coming out in April. We have provided a synopsis of where we are in the nine-page paper that we provided to you last week. I'm sure that my colleagues and I would be very happy to answer whatever questions we can.

Thank you, sir.

[The prepared statement of Mr. Morrison et al follows:]

TESTIMONY
BY THE
CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES
ON THE RESULTS OF ITS
CIVIL SPACE POLICY STUDY

BEFORE THE
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
OF THE
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
FEBRUARY 8, 1989

Witnesses appearing on behalf of CSIS:
James R. Morrison, David C. Acheson, Gilbert F. Rye
and Charles D. Walker

The Center for Strategic and International Studies (CSIS), under the leadership of then President Amos A. Jordan, initiated an independent, 18-month study of U.S. civil space policy in November, 1987. This bipartisan project was stimulated by the realization that there were a number of serious issues facing the civil space program, such as: the organization of the multi-agency effort left much to be desired; "space commercialization" was not well understood with conflicting objectives being pursued inconsistently, and; the need to reach a consensus on long-term program goals along with the strategies to meet those goals. At the time, CSIS could not identify any other independent organization studying civil space policy, so it resolved to address these issues.

A prestigious steering committee was established (see attachment A) by late 1987 with Brent Scowcroft and John McElroy as co-chairmen. In January, 1988, this committee set four principal tasks for the study: 1) to develop a white paper on "Why the Civil Space Program is important on the National Agenda"; 2) to recommend a better way to organize the civil space program; 3) to try to make better sense of "space commercialization", and; 4) to develop a white paper on top-level programmatic priorities to recommend to the new administration.

Two working groups were established in February, 1988. These were the Government Organization Working Group, with Gil Rye as chairman, and a Commercialization Working Group, with Charlie Walker as chairman. The members of those working groups are indicated in attachment B.

The following presents in summary form the principal conclusions of the study in these four areas.

Why the Civil Space Program is Important on the National Agenda

The Bush Administration should put civil space high on its priority list because space can make crucial contributions to national objectives in the environment, in competitiveness, and in education. Additionally, whether America likes it or not, whether America continues to be a major actor or not, a new age of exploration is underway. There can be no doubt that humans will land on and explore Mars in the 21st Century. Would the American people and the Congress countenance the U.S. standing aside from this historic effort? As President Bush has said: "...we must lead in space if we are to continue to lead on earth....I am fully and utterly committed to the peaceful exploration of near and far space. I am convinced this is not only an adventure but a responsibility, and one we shirk at our peril." Therefore, the administration should select solar system exploration by means of automated and piloted spacecraft as an important national objective. The piloted missions should be approached deliberately and with careful, thorough preparation, since some of the requisite technologies are not in hand as yet.

Regarding the environment, it is now clear that the atmosphere, the oceans and such land features as tropical rain forests are all part of an integrated system that must be studied on an integrated basis. An example of the problems facing us is that the earth's atmosphere, crucial to life on this planet, may be undergoing a rapid (one to two human lifetimes) and negative change (e.g., ozone depletion and greenhouse effect). We do not know to what extent these changes may be man-made or if the earth's life-sustaining atmosphere will be modified dramatically for the worse in the next 50-100 years. Urgent studies of these and other phenomena are required on a global basis. This cannot be done without utilizing space techniques to observe, measure and track large-scale phenomena around the earth.

Regarding competitiveness, the key to improving America's competitive performance is to increase U.S. productivity which, at an annual growth rate of about 1%, is lower than almost all other developed countries. The most important single factor in improving productivity is improving technology. This cannot be done without investing in the development of applicable technologies. Yet the U.S. is not keeping up with the competition here either. Civilian R&D spending in the U.S. is running at 1.8% of GNP, while in Germany it is 2.6% and in Japan it's 2.8%. If funds are expended wisely in the civil space program, it can be a major investment engine that pulls a long technology train. Consider one impact of being competitive in space. Each time a foreign space payload uses a U.S. launcher, it offsets the trade deficit by $40-100 million, depending on the launcher selected. This would equalize, in the current account, importing 2,000 to 5,000 Toyotas at $20,000 each. The sale abroad of U.S. communications satellite systems would bring an even larger return.

Regarding education, our country's future ability to compete depends more than anything else on the continuing availability of technically competent young people. Our record in creating and maintaining such a talent pool is poor and getting worse. Witness to this is a recent Baltimore Sun headline, "U.S. Pupils Last in Math, near Bottom in Science in 6-Nation Study." In order to graduate the same number of students from college, in technical disciplines, in the year 2000 as today, we will need to double the percentage of students entering these disciplines because the demographics show a sharp decline in numbers of students. We must, therefore, motivate primary and secondary school children to "turn on" to technical studies in an unprecedented way. As the Secretary of Education has said, "If students do not enjoy these subjects by the third grade, they are unlikely to invest the time and effort needed to pursue science or math in later years..." Motivation then is a key. An imaginative and aggressive space program is probably the best single motivator that can be identified for this very important national purpose.

Regarding exploration, on July 20, 1989, the U.S. will celebrate the 20th anniversary of the Apollo 11 lunar landing. At that time, which is only six months hence, there will be a national reflection on what the country was doing in space then and what it is doing now. It would behoove the President to build on Apollo's legacy of exploration and set the nation's course in space for the long term. The United States will not play a major role in this grand adventure of the 21st century on a reasonable cost basis if it does not set the objective early and work towards it, not on a crash basis, but with due planning and the gradual buildup of capabilities. The impact on the national budget in the short term need be very small. In doing so, specific benefits would accrue. We know from history that the will to explore has brought dynamism to the societies which take up the challenge. We should claim that dynamism for ourselves. Then, within the space program itself, efficiencies would be produced from establishing priorities, focusing efforts and developing the capabilities on a measured basis.

Finally, the foreign policy and national security aspects of a strong civil space program should not be ignored. A vigorous space program enhances the foreign relations of the United States in the strength that it lends to national prestige, which translates into international influence. This important aspect of the civil program is something the Soviets understand better that we do, unfortunately. The civil program contributes to national security through aeronautical and space technology development, through the development and operation of special facilities on earth and in orbit, through support for science and engineering education at all levels, and through cooperative programs with our allies which associates their expertise, resources and publics with our own goals and aspirations.

Organizing the Civil Space Program

The Government Organization Working Group (GOWG) was established by the Steering Committee in reaction to the belief that the organization of the multi-agency civil space program was not optimum. The weaknesses of the system were perceived to be: the existence of not one but two interagency space policy committees which differed with each other over important aspects of policy; the 11 agencies, members of the "senior" group, SIG-Space, had disparate functions and interests and, since SIG-Space was essentially a convocation of equals, the members tended to defend their "turf" and congeal disputes (some important progress was made despite this); in notable cases, the turf competition produced a complete block in arriving at policy (the fourth shuttle orbiter decision, for example); the stand-offs in SIG-Space tended to magnify the role of budget policy over space policy; SIG-Space was coordinated by the NSC but not led in the sense of a senior official being named by the President to lead the civil space program; the SIG-Space experience pointed up the larger truths that, in general, committees can coordinate but not lead, and that coordination, while important, is not sufficient for leadership. It was noted that a space council, since it is a high-level committee, might suffer a few of the same drawbacks.

The objectives that guided the development of CSIS' reorganization proposals were: to simplify and concentrate the coordinating authority; to make new delegations of authority unambiguous so as to minimize loopholes, jurisdictional warfare and lacunae in responsibility; to minimize reliance on new legislation, to maximize the use of the Executive reorganization authority, and to reorganize in a politically realistic way.

CSIS examined some eight possible alternatives against these objectives. In doing so, two realities became clear. The first was that, to enable Presidential leadership, a person and not a committee must be put in charge of civil space. The second was that a space council was going to be established no matter who became president. Therefore, its existence must be assumed.

In order to identify which official the President should name as the leader of the civil space program reporting to him, a working model was sought where a function being performed by multi-agencies was being effectively coordinated. The best model found was that of the Director of Central Intelligence, who combines the responsibilities of head of the CIA, coordinator of all intelligence requirements, activities, and budgets, and advises the President and the Congress on intelligence matters. Based on this model, CSIS proposes a "dual hat" Administrator of NASA who would also have a title of "Assistant to the President for Civil Space" (APCS) or "Director of Civil Space" (DCS). The APCS would have responsibilities for civil space comparable to those of the Secretary of Defense and the DCI for military and intelligence space interests; that is, he would speak for the President to all civil space activities of government (including policy relating to commercial space matters), and be the channel for them to and from the President. He would be responsible for the civil space agenda, for resolving conflicts among civil space activities, and for ensuring that the President's civil space policies are followed. In other words, the President would put someone in charge of the civil space program.

The Space Council, under the Vice President's chairmanship, would be adapted to serve a most useful, senior, policy level function and one not now provided for, i.e., an overview of integrated U.S. government space requirements and policies that overlap the civil, military and intelligence space activities. In this concept the Council would require only the membership of the APCS, Science Adviser and OMB to represent civil space concerns, and DOD, DCI and the National Security Adviser to represent national security concerns. So composed, the Space Council would have an important and feasible mission, a compact constituency, and would play the major role in integrating the totality of the U.S. space program, a function unfulfilled today.

Why single out the NASA administrator for the "dual hat" as opposed to some other civil space interest? Because a "free flier" coordinator, detached from line activity and resources, cannot expect to have much impact on events, and because NASA has the broadest stake and largest resource base in civil space. While other agencies have important interests in narrower segments of the program, they do not have the breadth of interest to lead the entire program. In addition, if another agency were to be put in the lead, it would be much harder to recruit a NASA administrator of desirable stature and ability. In making this recommendation, CSIS understands that the President must make it very clear to the APCS that he or she is fully responsible for the successful commercialization of space program activities.

Initial implementation of these recommendations could be made by the President issuing an executive order creating and defining the responsibilities and authority of the APCS. Later, after a deliberate interval of shake-down, the President could send to the Congress an executive reorganization plan incorporating the structural details of the executive order.

To recapitulate the advantages of combining the NASA Administrator with an APCS, it will: focus the lines of authority; not disturb existing agency structure or the jurisdiction of congressional committees; not impact the lines of authority for the national security space community; tie the oversight responsibility to the lead civil space agency; enable presidential decisions to be made expeditiously; make the Space Council more effective by giving focus and order to civil space issues that come before it and, implementation does not require legislation.

Space Commercialization

In the course of the discussions of CSIS' Commercialization Working Group (CWG), which occurred on a monthly basis for almost a year, it was interesting to determine that even the experts with which the group consulted differed widely in their views of space commercialization. Therefore, the CWG considered that it might be helpful to return to first principles. These are:

-space commercialization is an important investment in America's future;

-ultimately, only private capital can bring space technology to bear on the national objectives of improving America's competitiveness and balance of trade;

-many promising areas of commercialization are in their infancy, requiring more support from the government than these new initiatives will return in the short term;

-other governments are moving rapidly to seek competitive advantage;

-commercial space activities should not be regarded as just an adjunct to government programs, since the U.S. cannot be competitive in space or related technologies unless our private sector performance is competitive;

-while government is the major customer for space products and services at present, it is not organized to be an effective customer. For this and other reasons, the U.S. private sector is not being used to full national advantage.

There are two principal policy dangers at present: in overselling what commercialization can do, at least in the short term and, on the other side, in not supporting commercialization strongly enough (with many government agencies falling on one side or the other of this equation). Promising areas of commercialization must be identified and evaluated realistically and then pursued with determination.

With the foregoing in mind, some conclusions of the Council on Competitiveness in its report, Picking up the Pace, are applicable to space as well as other areas; viz., "We believe that facilitating U.S. private sector efforts to move ideas from the laboratory to the marketplace should be a top national priority", and "While other governments have used science and technology policies to promote industrial growth, commercial spin-offs from U.S. government programs, if they occurred at all, have been incidental."

The recent history of U.S. space commercialization is that, while a great deal of interagency conflict has occurred over it, substantial progress has been made particularly in launch vehicles and in the Reagan policy statement of February 11, 1988. The major difficulties are that most of this progress took place in the last year of the Reagan presidency, the Congress was not involved and the strategies required to meet the goals were not addressed.

Therefore, the principal CSIS recommendation on commercialization is that the Bush Administration should act rapidly to establish a task force, with congressional and private sector representation, to develop specific recommendations on commercialization within six months. The beginning point for this effort should be President Reagan's policy statement of February 11. However, implementation strategy as well as goals should be addressed.

The CWG delved into five areas of commercialization: launch vehicles, remote sensing, communications/navigation, infrastructure and microgravity processing. The Steering Committee considered that, except for remote sensing, the conclusions of the CSIS Space Policy Study should be kept at the general, overarching level. We did not attempt to make particular business judgements. Remote sensing was considered an exception because, if the U.S. cannot commercialize successfully the mature areas of space applications, it does not bode well for the new, promising areas. Therefore, the CSIS study has produced a paper entitled, "Remote Sensing: A High-Payoff Commercial Opportunity in Space". The basic idea, to expand the market for commercial remote sensing products by including meteorological data with the Landsat data, is not new, but the implementation is. There is no intent to dismantle the weather service; only for NOAA to obtain from the private sector the data it needs instead of operating the systems itself. This is entirely consistent with present U.S. government policy. There would be no substantive change to current data practices, and certainly no commercialization of the NWS, its functions, or any data related to the protection of life and property. The following benefits would be realized by combining the two systems into one, and by requiring NASA where possible to fly its R&D instruments on commercial spacecraft:

-economies of scale in space systems;
-economies of scale in ground tracking and data systems;
-a large, assured market for the private sector to build upon (on the order of hundreds of millions of dollars);
-an expanded private sector role in space;
-a reduction in operational activities by the government.
-no subsidies would be required and no loss of government control.

We strongly recommend that the new administration consider this approach, which we feel has a real chance of commercial success.

Recommended Program Priorities

Environment:

The CSIS study has found no controversy from any quarter about whether NASA should mount the "Mission to Planet Earth", much as described in the "Ride Report". "Mission" is a program for which the feasibility exists and which serves a pressing national and global need to study large scale, adverse environmental effects relating to the geosphere/biosphere. Therefore, we strongly endorse this initiative. This program should be mounted as a constructive international venture, U.S. leadership for which would be welcomed worldwide.

Exploration of the Solar System:

This priority was dealt with at some length under "Why the Civil Space Program is Important on the National Agenda", above. Important points to emphasize are that: the overall objective should encompass the most efficient use of both automated and piloted spacecraft in solar system exploration; there is no need to pursue this objective on a (highly expensive) crash basis, and; the U.S. program needs a major long-term goal now to focus near-term technology and infrastructure development efforts, life sciences research and to plan its on-orbit operations. Assuming the adoption of this goal, the major objectives for space station "Freedom" should be refined and sharpened as: 1-preparing for and supporting the piloted missions in the Mars exploration program, and; 2-supporting future U.S. competitiveness through conducting high priority microgravity science.

Science

The CSIS study endorses the excellent long-range strategy which NASA has developed for the core space science program. It should be supported as a matter of priority, including the life sciences and further investigation of the universe by means of the Great Observatory missions. While there always will be disagreement among scientists over which mission should come next, NASA and the scientific community have successfully wrestled with that ranking process for the history of the agency, and are capable of doing so now. Two important ingredients to enable a successful program, however, are consistent funding support and not tying important elements of the science program unnecessarily to the human space flight program (most planetary, astronomical and geoscience missions are better conducted unmanned).

Applications

A long range plan for developing the practical applications of space technology, including selected technology validation projects, should be developed, much as NASA has done for the space sciences. This should include planning for the transition of the applications into commercial use in the private sector, wherever that is appropriate.

Launch Vehicles

Reliable and cost effective access to space is the sine qua non for success in all aspects of the space program. The Bush Administration will face major questions relating to future launch vehicle requirements and technologies, and how to combine the diverse interests of the private sector and the U.S. military and civil space communities into development efforts that will permit timely, affordable and competitive space exploration and utilization missions. Therefore, CSIS recommends that the new Space Council establish a commission with representation from government and the private sector to develop and provide to the Congress within one year a national space launch program covering a twenty-to-thirty year horizon. The program should include proposed budget commitments for the first five years and program costs for the second five years. It would cover both government (civil and military) and private sector activities. It should set the stage for the expansion of cost-effective public and private sector space activities for the long-term.

Space Technology

CSIS strongly endorses the recommendation of the NRC study entitled, Space Technology to Meet Future Needs", National Academy Press, 1987, to the effect, "...for the next decade the NASA R&T effort in this area (should) not be allowed to go below 7 percent of the total NASA budget and that these resources be protected from short-term requirements of major operational programs."

Multi-Year Funding

Continuity is important in space projects which have durations of many budget years: how to stabilize planning, how to minimize costs, how to strengthen management and accountability, how to improve contractor efficiency, and how to keep commitments to foreign partners and U.S. industry. In all of these matters multi-year funding is the key and missing sine qua non. Multi-year obligational authority and appropriations are going to be, increasingly, preconditions to successful joint programs.

----------------------------CSIS------------------------------

The Center for Strategic and International Studies is a research organization founded in 1962 to foster scholarship and public awareness of emerging international issues on a broad, interdisciplinary basis. It is bipartisan and nonprofit. Its areas of research are selected in consultation with its governing bodies, and its work is entirely unclassified.

January 11, 1989

EXPECTED ATTENDANCE AT THE JANUARY 16 DINNER OF THE CSIS COMMERCIALIZATION WORKING GROUP

University Club
(16th St. between L & M)
6:30 - cocktails; 7:00 - dinner; 8:00 - remarks

WORKING GROUP MEMBERS

Charlie Walker-Chair (McD D.)
John Egan (Egan Gp.)
Phil Culbertson (Evans Found.)
Joel Greenberg (Princeton Syn.)
Otto Hoernig, Jr. (CONTEL)
Diana Josephson (vice Dick Brackeen) (Martin)
Peter Stark (Intec)
James Taranik (DRI)

Possible attendees:
Joe Allen (SII)
Dave Wright (GE)

SPEAKERS

Ken Pedersen - NASA, Jim Beggs - SPACEHAB, Courtney Stadd - R. Duffy Wall & Assoc.

GUESTS

Rick Endres - Director, Office of Space Commerce, USDOC

Dick McCormick - Assistant to the Secretary for Space Policy, Office of the Secretary of the Air Force

Bob Hahn - CEA

Larry Herbolsheimer - Deputy Assistant Administrator for Commercial Programs, NASA

Craig Crutchfield - Office of Commercial Programs, NASA

David Moore - CBO

H. P. Goldfield - law firm of Swidler and Berlin

Brad Mitchell - Space TOC for the Bush Transition Team

Jim Carpenter - Bush Transition Team for space

CSIS STAFF

David Acheson, Addison Richmond, Jim Morrison

Mr. NELSON. Thank you.

Mr. Rohrabacher.

Mr. ROHRABACHER. Nothing right now.

Mr. NELSON. Mr. Stallings.

Mr. STALLINGS. Not right now.

Mr. NELSON. Mr. Schiff.

Mr. SCHIFF. Just one question, sir. Do you envision, if there is this one person appointed that you have recommended what would be that position's relationship with respect to the military in space? Is that considered in your proposal?

Mr. MORRISON. Yes.

Mr. Rye.

Mr. RYE. The proposal that we're making, I think, is somewhat new; at least we haven't heard of it being proposed by anyone else. We're putting someone in charge of the civil space program.

One of the things that we note in our report is that since the beginning of the Reagan administration there are many organizations within the executive branch that have become involved—and rightfully so—in space activities. We endorse that. We think that's useful and it's healthy for the space program.

However, the Challenger—in the aftermath of the Challenger accident, I think it highlighted the fact that at least the executive branch is not speaking with one voice. There's the opportunity for a perception that the policy, the national space policy of the country, is somewhat confused, and so we think it's important that one individual be appointed by the President as his chief spokesman for the civil space program.

We think that if one looks at the candidates for that kind of position, that it naturally should fall upon the shoulders of the NASA administrator, and so we are proposing that the NASA administrator be appointed with a second hat, if you will, in a position of assistant to the President for civil space, much as we do in the intelligence world, on the national security side, where we appoint the Director of the Central Intelligence Agency as the Director of central intelligence. In other words, he not only runs the Central Intelligence Agency itself but also coordinates the activities of all the organizations and other branches of Government that have intelligence responsibilities. So that that kind of a responsibility is, we think, important to bring coherence to the civil space program and to elevate the importance of the NASA administrator in terms of his responsibilities and hopefully provide him with access to the President and the ability to provide the President with a focus of advice.

We would view the—in terms of the military arena, we would look toward the National Space Council, the new National Space Council, as the principal focus for coordinating the activities across the national security as well as the civil and commercial areas, so that the Vice President, in his role as chairman of the National Space Council, would be the focus of attention for trying to coordinate the activities of both the national security side as well as the civil side. We're not recommending any changes to the current way of doing business on the national security side.

Mr. SCHIFF. Thank you, Mr. Chairman.

Mr. NELSON. Mr. Rohrabacher.

Mr. Rohrabacher. If you have one fellow in charge of the whole program—how are you doing, Gil?

Mr. Rye. Fine, Dana. How are you?

Mr. Rohrabacher. It's good to see you again.

If you have one fellow in charge of the whole program and he has an inclination that, let's say, it's a wrong inclination—let's say it's something that a lot of you folks wouldn't agree with, and as we have been indicated earlier, before I had to go off to another hearing, that there is a lot of disagreement even among scientists as to exactly what our priorities should be—isn't it better to have authority a little bit spread out rather than have it in the hands of one fellow if there's a—if there's a large—if there's a big level of disagreement even among scientists as to exactly what our priorities should be? Because if you get one fellow in there, a lot of people's viewpoints aren't going to be taken into consideration. Isn't that right?

Mr. Rye. Well, I guess there's always that risk, but I think if the President makes it clear to his assistant to the President for civil space what his responsibilities are and that he's holding him accountable for—and "accountability" is a very important word. You learn that in the private sector very quickly if you're responsible for bottom line. You're accountable and responsible for delivering a product or a result within a certain period of time, and I think that's—it's important to try to infuse some of that into the Government as well, and there's always the risk that there—there will be differences of opinion, and I think we—you would look toward the gentleman in this capacity to try to coordinate those activities, and he would have to do that objectively or risk these individuals going through their own Cabinet department-level secretaries into the President with these disagreements.

On the major issues, you know, the President is going to have to get involved, and on issues that deal with a program of national importance like the space station, the President will have to get involved and, inevitably, will have to arbitrate differences of opinion on major programs.

But the—one of the objectives here is to try to keep every issue from coming into the Oval Office for resolution. The President does not have the time to deal with every issue in the civil space arena. You have to have somebody who is—who is coordinating those activities on a day-to-day basis and one who is familiar with those issues and can address them with some credibility.

Mr. Rohrabacher. Are we talking about somebody with authority or just someone who is a coordinator?

Mr. Rye. No. I think he would have certain authorities and responsibilities. I would think his chief role would be as a coordinator, but I think we would recommend that the President look toward this individual as the primary one who is responsible for developing civil space policy and trying to advocate that in the National Space Council and in his relationship with the President.

Mr. Morrison. Mr. Rohrabacher, if I can take a different approach to answering your question, if you—we took the theory that you stated that maybe more than one individual is desirable, then what you would be saying, in my mind, wouldn't it be desirable to have a committee running the Department of Defense? and the answer, I think, is clearly no; you need an individual. He may be wrong at some time, but there are checks and balances within the system. In this case, there will be a Space Council to which this individual will report where he will have a chance to hear the other agencies on the larger issues; you'll have a Vice President on top. So checks and balances will be there.

The question is, what we are trying to do here is to enable leadership which was not enabled, for example, after the Challenger accident in the previous administration. We wish to enable leadership, and in order to do that you need a leader, in our conclusion. A committee is too often a jury of equals which serves to annihilate each other in the process, and it serves to prevent initiative and leadership. What you wind up with very often in that context is something that was discussed here earlier, is that you wind up with budget policy which drives everything, and you wind up with no space policy with which to interface with the budget policy.

So, therefore, in our view, the selection of the leader for the civil space program is extremely important to develop the policy to take to the White House and the OMB.

Mr. **Rye**. And it's probably more important now in the environment of austere funding where priorities will have to be developed and made, and committees are good coordinators of success but very poor managers of issues and problems, and someone has to be in charge.

Mr. **Nelson**. How would you figure that the National Space Council would fit with your proposal where the NASA administrator is also the special assistant to the President for civil space?

Mr. **Rye**. We're suggesting that the assistant to the President for civil space be the spokesman on the National Space Council for the—for the civil and commercial space community. If he is not, then I think you are diminishing his role and authority and responsibility for oversight over those activities.

Mr. **Nelson**. Do you see—under your plan, do you see any problem with my suggestion that the NASA administrator be the vice chairman of the National Space Council?

Mr. **Rye**. I would foresee a problem.

Mr. **Nelson**. Why?

Mr. **Rye**. If, in the absence of the chairman, the vice chairman was asked to chair a key meeting at which a program or issue related to the national security community were to be addressed, I think it—it might create a problem if, in that role, the deputy chairman were to make a decision that were to adversely impact the national security community.

So I think just as the civil community would have some problem with the Secretary of Defense making a decision relative to the civil community, the reverse would also be true, and so I think it would be difficult, especially on key issues, for anyone other than the Vice President, by name, to chair those meetings.

Mr. **Nelson**. Well, by what you've just laid out, if you exclude defense space—i.e., the Secretary of Defense—and if you exclude civil space—i.e., the NASA administrator—and you're looking for a vice chairman of the National Space Council, then you're going off to somebody who doesn't know anything about space.

Mr. Morrison. Mr. Chairman, we faced the same question, and we stopped short of there. We stopped looking for a vice chairman of the Space Council.

Mr. Nelson. In other words, you don't want one.

Mr. Morrison. Exactly.

Mr. Rye. That would be my recommendation.

Mr. Nelson. Go back to the time when the National Space Council was first formed. Lyndon Johnson was its chairman, and the administrator of NASA was the vice chairman. Why doesn't that model work now?

Mr. Rye. Because I think in those days the Space Council was only addressing civil issues.

Mr. Morrison. Mr. Chairman, you're raising a point of fact that I—I'm not sure about. I do not recall—and this we're checking, and I defer to your expertise here—that the NASA administrator was the vice chairman of the Space Council.

Mr. Nelson. It was my understanding that he was. Is that not true?

Mr. Rye. But I think the charter of the Council in those days was limited to civil space issues. I think there were separate mechanisms in place to coordinate military activities.

Mr. Nelson. Well, if you look at the dollars involved, in the fiscal year 1989 budget, military space certainly overshadows civil space, $44 billion to $11 billion. So if you look at it just like that in the National Space Council—but a lot of that space policy with regard to the military is a matter that is going to be hammered out in the National Security Council, not the National Space Council. So why then do you want to take away from the focus of the civilian space program in the National Space Council?

Mr. Rye. I wouldn't look at it as taking away, I would look at it as reinforcing the importance of the civil community.

I think there is—my experience is, there are a lot of activities that require careful coordination that overlap the national security and civil arena, space transportation probably being the most vivid one, but there are also areas of technology and a whole myriad of areas that require some high-level coordination, and it all comes together in the White House, and I think it will be having the Vice President oversee that coordination process.

But I must say that my experience is that most issues related to the military arena are addressed within the Department of Defense and rarely see light within the White House. The Secretary of Defense has his own process in place to address those issues, to make tradeoff decisions, and he normally doesn't drop in the lap of a committee in the White House an issue unless it really does overlap into other areas of responsibility—for example, the shuttle.

So I wouldn't foresee that there would be a myriad of issues that would require the attention of the Space Council from the military community.

Mr. Rohrabacher. Mr. Chairman.

Mr. Nelson. I'm sorry. Mr. Stallings also wanted a question. Go ahead, Mr. Rohrabacher.

Mr. Rohrabacher. I was just going to ask if the final decision is going to be the President's in the end anyway, why aren't we just enhancing the role of the science advisor to the President rather than looking at this whole new area of authority?

Mr. **Morrison**. If I may try and answer that, when we defined—settled on, after considerable discussion, what we said, two-hatting the NASA administrator as the assistant to the President, we looked at the other candidates for this, and the kind of logic that you go through is as follows:

We did not wish to put the Vice President as the head of the Space Council in an in-line activity operating one of the section of the U.S. Government program; that didn't seem to make sense. He should be looking at the totality. We're talking about setting goals here. The Vice President and the Space Council would do a marvelous—make a marvelous contribution to the U.S. space program by helping to refine and sharpen those goals for the new administration. So we ruled out the Vice President.

We ruled out bringing in a free-floating individual. You just pick somebody off the street—not quite—and say, "Okay, you're the head of the space program, the civil space program, for me." There are two drawbacks to this, in our view. One is that you bureaucratically layer the NASA administrator, who everyone hopes, I think, is going to be a superlative individual, and you're not—if you start layering this individual bureaucratically, you're not going to get that good an individual.

Another aspect of this is that if you bring this free-floating individual in who does not have an organization behind him, does not have a budget, the people who have chips on the table in Washington are not going to pay much attention to this person; the power isn't going to be there.

So then we began to look at who the players are who would make sense. We did not choose the Secretary of Transportation because, while the function of the Department—the regulatory function of the Department of Transportation is extremely important, it's just a small part of the program.

We did not choose the science advisor because history has shown that the science advisor is terribly interested about science but isn't very much interested in competitiveness or commercialization. In fact, if I can refer to the statement of my predecessor here, that was not referred to in the statement by the—by Dr. Stever. That happens to be—it's not new; that's generically the approach of the Office of Science and Technology Policy. In our view, the program is broader than that. Competitiveness is important, so you need somebody with a broader view.

Mr. **Rohrabacher**. Well, you know, having worked at the White House, I seem to remember—and I think Gil may verify this or not; I don't know what kind of battles he had with Jay Keyworth. But he seemed to be a champion of just the very thing you say that the science advisor isn't a champion of. I mean he was really for commercialization.

Mr. **Morrison**. You perhaps can find individuals who can play the role, but we—not knowing who the individuals are going to be, we try to look at the totality, and on the side, taking the science advisor point, we did not select the Secretary of Commerce for this role, because while the Secretary of Commerce is very interested in commercialization, traditionally they don't care much about the science side.

If you look at the totality, very comparable to the intelligence side, where the CIA—there are other agencies in the picture, but the CIA has the greatest breadth. NASA has the greatest breadth in the civil space program, and it made sense to us, because of that breadth, to put the two-hat position there.

Mr. **Rye**. I think the Nation naturally looks to the NASA administrator as the head of the u.s space program, and I don't see that we should do anything to diffuse that perception. I think that perception can be legitimized and the administrator can be held accountable for a broader set of objectives.

Mr. **Rohrabacher**. I would just suggest that it might be, in terms of having the public being aware that their vote has counted for something and that actually this is the democratic process, that perhaps if you have someone who is directly appointed by the President as part of his staff, that it probably would get a lot better, and also the fact that he's close to the power of the presidency, that that might carry a little more weight than having someone who was the head of an agency outside of the White House structure.

Mr. **Acheson**. If I may make a comment, the head of NASA does report to the President. The consensus that we have seen pretty much everywhere we have looked and listened is that it's desirable to enhance the access of the NASA administrator to the President. It would do the reverse of that, in our judgment, if you have him coordinated by either the science advisor or some other functionary who reports to the President.

Mr. **Nelson**. Mr. Stallings.

Mr. **Stallings**. Thank you, Mr. Chairman.

Would you, one of you gentlemen, give me your impressions what you mean by space commercialization?

Mr. **Rye**. Charlie, you're on.

Mr. **Charles Walker**. Thank you for asking, Mr. Stallings.

Space commercialization, to us—and we took some considerable amount of time to, in fact, establish within our own minds what that did mean, because we see—we have seen a great deal of debate and, in fact, consternation as to what's meant by this.

What we established, basically, as space commercialization was activities at which the private sector's capital, dollars, are put at risk, that provision of—for the provision of activities that will utilize the unique qualities of space to achieve products or services.

So that, in a nutshell, is what we saw commercialization to be, and we saw it to be different from privatization. We saw privatization to be the handing over of Government-owned and developed assets to the private sector for use by the private sector in satisfying a market, be that market the Government or be it private sector or a combination of the two.

Mr. **Morrison**. Mr. Stallings, just a brief addition to that. In addition to private capital being at risk, the concept of there being more than one customer than the U.S. Government, if not at present, then the prospect of it in the reasonable future is extremely important.

Mr. STALLINGS. In earlier testimony, Dr. Stever said that commercialization is going to be controversial. He didn't elaborate, and I didn't get a chance to ask him that question. Do you see controversy in this commercialization?

Mr. CHARLES WALKER. Yes, I see there having been controversy in the arena of what, by any definition, has been called commercialization, and I, too, do not know exactly what the National Academy, Dr. Stever, had in mind with that comment.

But there is debate with regard to commercialization; there is controversy in terms of what can, again, by any definition, thinking here in terms of public debate and discussion on the matter—there is—there is debate on what can be commercialized, by anybody's definition, what can successfully utilize either the Government's Government-developed assets when projected to a private sector use or in terms of how the public—or, rather, how the private—how private capital investment might be manifested in the space arena to provide goods and services. There is controversy on risk management, there is controversy on term of investment to pay back. There is controversy.

Mr. STALLINGS. Then you go on, or whoever is responsible for the document here that I'm referring to, that Dr. Morrison was apparently speaking from—it said, "Ultimately, only private capital can bring space technology to bear on the national objectives of improving America's competitiveness and balance of trade." So you see, in a sense, the future of our space program is tied up in this commercialization.

Mr. CHARLES WALKER. I would say that the gist of that is that we do see that when you think of space, in the context of national economic and technical competitiveness, that to really satisfy the needs in terms of space as a potential contributor to the balance of trade question, as a potential contributor to international participation in which somebody might lead, and, again, debate as to whether the United States should be a leader or not, but in international participation you have to either lead or participate, one or the other, and even to participate you've got to be technically competitive. So it applies in the leadership in the international competitiveness arena as well, in all those aspects of our national and international involvements.

When you think of space, the private sector is vitally important and can be seen as, in fact, perhaps the only effective means for us to answer those questions, to be a player in those arenas.

Mr. STALLINGS. Then you see our goals in space as being directed by the greatest good coming from commercialization?

Mr. CHARLES WALKER. No, that's not true. We don't see commercialization as being the answer at all for—to any of the questions with regard to space.

National goals: national goals must be set in a public arena and for the public good as the primary objective. Space commercialization, commercial space activities, I think rightly can be seen as—and here I'm trying to avoid a term that's already been used and really has been overused, which is "spinoff."

Commercialization of space in the arena of national goals and objectives is a part of—is a part of that play, that play on the national and international stage of human activity, but it is not the answer, nor is it the driver, to what or how we do that in space.

Mr. STALLINGS. Because I guess what I'm getting to is, the drift I've got from looking through this—and I'm sorry I missed the entire presentation and just came in towards the end, but the drift I'm getting here—and I take it the next step that is in this document—it says, "Many promising areas of commercialization are in their infancy, requiring more support from the Government than these new initiatives will return in the short term."

I get the impression that we're operating this space program sort of like a Small Business Administration; in other words, we're going to keep this going until we get the spinoff industries, until we get the support industries, where they can carry their own, and then perhaps Government can move out of it. Correct me if you're trying to project something different, and, like I say, I've not read the entire document and I will do so.

Mr. MORRISON. I think the short answer is that that's partially correct. In order to improve the competitiveness of the United States—and we think that space can contribute to competitiveness—one of the objectives, not the objective, certainly not the only objective, but one of the objectives should be to assist the private sector, these incipient industries, as much as possible.

Now you were asking about the controversies. When you talk with people expert in the program, one approach by many people is that NASA is an R&D organization; what NASA should do with its R&D, if a good idea comes out of that, somebody will pick up and off they go; and that's fine.

On the other hand, further down the page that you were quoting from before, I would like to go to the report from the Council on Competitiveness report called "Picking Up The Pace," and, in our view, a number of the conclusions in that report play to the space program at the present time, and I will read those two quotes. "We believe that facilitating U.S. private sector efforts to move ideas from the laboratory to the marketplace should be a top national priority." And, the other quote, "While other governments have used science and technology policies to promote industrial growth, commercial spinoffs from U.S. Government programs, if they have occurred at all, have been incidental." We wish that not to be so incidental.

Mr. STALLINGS. Thank you. Thank you, Mr. Chairman.

Mr. ACHESON. Could I suggest one homey illustration that underscores Mr. Morrison's point. If you have a kind of Government use of launch vehicles which would presuppose that the private contractor takes a little risk, develops his own design to meet performance specifications rather than design specs, and he comes up with a really highly cost-effective launch vehicle which can be sold, let us say, to the European Space Agency for a launch of one of their missions, such a launch, regarded as an export, is worth the equivalent, let us say, of exporting 5,000 automobiles at $20,000 apiece from the United States. That's the kind of interplay between Government use, private risk, and private innovation that we have in mind.

Mr. STALLINGS. I agree with you, and I agree with the earlier statement that we've not done a very good job of transferring the technology.

My problem is this, to be very honest with you. This committee is going to recommend a significant increase in funding for the space program. If I go home to Idaho and sell that program on the basis that we are going to have nice spinoff industries and maybe in the future we're going to have some things that you'll be able to use in your home, that several companies are going to make a lot of money on this program, that's not very exciting.

The space program, from Kennedy's identifying the moon in 1961, has been a visionary thing—we're doing it because of man's innate desire to search, and to discover—and to explore, and people get caught up with that, and I think that's why it's so popular among the kids, not because there's a profit motive to be identified.

So I guess what I'm searching for today is, what are our motives? What is driving our long-term goals? What is driving the arguments here so that we should spend so many billions of our taxpayer dollars for a program? Is it to enrich companies through the spinoffs of this, or is it for knowledge, or is it for exploration of the last frontier?

Mr. MORRISON. Mr. Stallings, of course this is something that the next administration is going to—the Bush administration is going to take leadership, hopefully with the Space Council, to define. But in our terms, what we have recommended is ECEE—environment, competitiveness, education, and exploration.

Mr. RYE. That took less than 40 seconds.

Mr. STALLINGS. Very good.

Mr. NELSON. One of your recommendations is that you commercialize weather satellites, and I take it that you feel like that that will save the commercializing of the Landsat program. Is that correct?

Mr. MORRISON. In one sentence, yes.

Mr. NELSON. In one word, yes.

Mr. MORRISON. In one word. Your description, one sentence, yes.

Mr. NELSON. In a recent Aviation Week comment, they tend to indicate that there is commentary going on between a merger of Landsat and SPOT. What do you think about that?

Mr. MORRISON. Mr. Chairman, I have to make a disassociation here. Our study did not study that. So on behalf of the study, I can't respond. What I give you is my personal view.

Mr. NELSON. Right.

Mr. MORRISON. My personal view is that we are far better served in getting U.S. Government to work with U.S. industry first before we go overseas than we are going overseas for the initial solution. Other countries do it that way.

Mr. NELSON. Okay. Let's go back to your study now. Your study was, to make Landsat viable, we ought to commercialize weather satellites. How does that work?

Mr. MORRISON. All right. First, a bit of a disclaimer. Our expert in this area is Dr. John McElroy, who, as you know, was a senior official at NOAA, and he's not with us today, so I'll do the best that I can in his absence.

The basic definition—and it's about a threefold step process here. It will be very difficult, if not impossible, to commercialize the Landsat system based on the size of the market that is there at the present time or foreseeably. You're talking about a market on the range of, at the present time, $20-40 million, maybe $50 million in five, six, seven years. Anyway, we're talking in tens of millions of dollars.

On the other hand, you're talking about a space system that is in the hundreds of millions of dollars region. The market is not there to commercialize it. The question then becomes, how do you increase the market to be able to support the system?

The Department of Commerce, NOAA, is spending somewhere between $300 and $400 million annually on its meteorological space systems, on the overall systems, in order to acquire the meteorological data. What we are recommending is that you combine the meteorological market with the Landsat market and that by doing that you will create the basis, a sound economic basis, on which to commercialize the overall system.

The U.S. Government, on the civil side at the present time, is running three remote sensing programs. It's running the meteorological system, it's running the Landsat system, and it's running the NASA R&D system which is going to grow considerably over the years.

If you can combine the first two, the meteorological and the Landsat systems, on a commercial basis and require—I'm not quite sure of that word, but I'll use the word "require"—NASA to fly its R&D sensors where it makes sense on the operational vehicles first, and then if that's not possible then on research vehicles, you stand the chance of bringing much more rationality in the system; you will have one space segment instead of two; you can have one ground segment instead of two; the potentiality is there, in our view, the real potentiality of making this a viable commercial enterprise.

The next step, we believe, that needs to be taken in this is, we are making the recommendation, but one of the agencies or the Congress, in our view, should require a detailed technical and cost analysis of this so that we all have the figures in front of us to know exactly how we should progress. But we do believe that this proposal, which is not new—it was tried five years ago or so but denied for nonsubstantive reasons—that the merit is there to go back and take another very hard look at it.

Mr. NELSON. Underscoring what you said, by March, unless Landsat gets a new infusion of money, it's out of business. Now, what I question in what you just said is that, whether you would want to take something as sensitive as weather satellites and turn that over to private industry since its primary customer is the Government.

We went through this drill about two and a half years ago, and we came down on the side that we did not want weather satellites to be in the hands of anybody except the U.S. Government. Do you want to comment on that?

Mr. MORRISON. Yes. Thank you, Mr. Chairman.

What we are not proposing—the proposal last time around included privatizing the National Weather Service and other things.

We are not proposing that. All we're proposing to do is to follow present U.S. Government policy as enunciated in the Reagan policy statements of January and February of last year that if the Government can buy a product on the commercial market, and there's certainly no reason that the commercial industry cannot produce this product, then that is what the Government should do and get out of the production itself.

Now why—why the Government should feel very constrained about purchasing data from a major U.S. company that would be producing this I'm not at all clear. It—I see no reason offhand why the private entity would be less certain than U.S. Government funding.

Mr. RYE. Mr. Chairman, I was involved in that debate to some extent the first go round, and, as I recall, in the media, the issue became, are we going to require a farmer in Iowa to pay for weather data, and under the way I think that it was perhaps being proposed at that time, it could have been interpreted in that way.

What Jim has just suggested, I think, would go a step forward in trying to clarify and simplify the proposal in that it would still be a basic U.S. Government responsibility to provide weather data to its citizens. It's just that it would be paying for a service from satellite system that would be commercialized.

Mr. MORRISON. That is correct.

Mr. ROHRABACHER. Mr. Chairman.

Mr. NELSON. Mr. Rohrabacher.

Mr. ROHRABACHER. Well, of course, there is no question about whether that farmer out there is going to pay for that weather data, because he's paying for it no matter what, anyway. Taxes is what's paying for that weather data coming down there, and the question is who can best operate these type of situations, these functions, and I, for one, have thought that the private sector has done a heck of a lot better job at providing services—goods and services over the history of this country than the Government has, and if it comes down to the Government, the bureaucracy, running weather satellites or whether we are going to put it into the private sector, I'll bet you that it would be better run by the private sector, because the public is going to pay for it one way or the other, and who's going to be more efficient?

Mr. MORRISON. That was our conclusion, Mr. Rohrabacher, in addition to which, if you enable the private sector the chances of them going out and finding additional markets that are not there in this area are very good.

Mr. CHARLES WALKER. Mr. Chairman, if I might—

Mr. NELSON. Just one second.

The normal question of competition, the market, when we went through this discussion two and a half years ago, is not there with the weather satellites, because the Government is buying 95 percent of the data. So you've got the Government coming right back as the main customer of this weather satellite.

Now given that little different wrinkle than what would normally be the case, if you could tap this vast new potential of peddling this kind of data as a commercial enterprise, that would be one thing, to markets other than the U.S. Government. How does your feeling—how does your conclusion stand with the fact that the Government is almost the entire customer?

Mr. MORRISON. We agree with your conclusion at the present time, but if you look to the future and you enable the private sector here, and you allow them to use their expertise and entrepreneurialship to go after additional markets—

Mr. NELSON. Such as?

Mr. MORRISON. The value-added industry out there for providing special markets. I'm not going to predict where that could be five years from now if you enable this.

One of our ground rules, as we discussed with Mr. Stallings earlier, is that we do not believe it's commercialization unless two—or privatization, unless two things happen. One is, some private sector capital has got to be put at risk here, and you have to have the prospect of more customers than just the Government. This happens to be an area where we believe that can happen.

Mr. CHARLES WALKER. Mr. Chairman, a couple of things specific to your question. We want to reiterate that the proposal is for the combination of—and operation of the meteorological satellite system—that's not the Weather Service again but the satellites on orbit—and the Landsat, the remote sensing systems.

There is a large community that believes that, given the opportunity to meld capability, instrument capability, to look at weather as well as to look at ocean state, to look at the physical characteristics of the ocean remote sensing information, and even look at land use along with weather, that, while largely uninvestigated, the precept is that there is great value-added in looking at the symbiosis of these monitoring capabilities. That hasn't been tried before.

With this kind of proposal, there would only be a transfer to the private sector of orbital resources, of ground station capability—tracking and communication to some extent, not the Weather Service again, not the use or distribution of the meteorological information for the public benefit; that would still be under the National Weather Service and its arms.

The benefits, I think, or the potential here have to be viewed in terms of both weather—the Weather Service or what meteorological system is on orbit and remote sensing systems, the symbiotic potential of the symbiosis of those in terms of really determining what the environment is here on the surface, on the oceans, and under the surface of the oceans, and the benefit of that enhanced knowledge not only for the public good but for commercial opportunity. So I think that there's an aspect there.

I also wanted to mention something with regard to Mr. Rohrabacher's point, which is that over the same period of time that the U.S. Government has developed and operated on-orbit meteorological systems beginning with Tiros I, it has also seen the support of and then the establishment of a separate commercial operation—operations for communications from orbit. The Federal Government buys a lot of communications from commercially developed and commercially provided on-orbit and operated communications satellites. I think that is a good example of, in fact, the kind of capability that the private sector is able to provide with orbital systems—tracking and operation of orbital systems that might apply here.

Mr. NELSON. You know, this whole discussion might be an appropriate first discussion for the National Space Council when it is getting formed, because if what you have laid out is, in fact, a viable—two and a half years ago, we didn't feel that way. We didn't feel that way unanimously on this committee about the weather assets. But if there are changing reasons to say that you could preserve a viable commercial Landsat, commercial enterprise, by bringing it together with the weather satellites, then I think we ought to look at that.

Mr. MORRISON. Mr. Chairman, we think that real potential is there.

Mr. RYE. And still have the Government have the basic responsibility for providing weather data to its citizens, I think.

Mr. NELSON. The privateers will have a ball with this one, won't they?

Mr. MORRISON. Isn't that wonderful?

Mr. ROHRABACHER. Yes. They pay taxes.

Mr. MORRISON. Mr. Chairman, just to summarize that, in our view, this proposal has the potentiality of bringing us economies of scale in the space system, economies of scale in ground and tracking system—data tracking systems, an assured market for the private sector to build upon which it does not have today, an expanded private sector role in space, and a reduction in direct Government operational activities in space.

Mr. NELSON. Did you decide to come back to us as our ranking Republican on this committee, Mr. Walker?

Mr. ROBERT WALKER. No. I just decided to come back to listen.

Mr. NELSON. I thought somebody must have called you and said, "They're talking about privatization," and you came back immediately.

[Laughter.]

Mr. ROBERT WALKER. It sounds like my kind of subject.

Mr. NELSON. All right. Let me just hit a couple of other topics and we'll wrap up here.

We've got the twentieth anniversary of Apollo 11 coming up, and this conjures up great visions to me. This is the time to be visionary. Do you think that we could get something going in the way of creating new visions around this anniversary and setting new goals and then committing to them? What do you think?

Mr. MORRISON. Yes, sir. I think from the standpoint of the study, yes, the opportunity is there, and, in fact, in a defensive mode, I think that the Bush administration must take this into account. The country will—in six short months, is going to be reflecting very carefully on what happened 20 years ago and is going to be looking at the present state of the space program and asking where we are and where we're going. I think the present administration is very politically astute, and I would be surprised if they did not pick up on that.

Now, once that is done, the other part of your question is, commit to that. Whether there is a space policy that can help orchestrate the budget policy instead of all the flow being in the other direction depends strongly on the White House stepping up to that, and I'm hopeful but that's yet to be seen.

Mr. NELSON. Well, we said earlier in this hearing that we can establish a goal, commit to it, and then you can work on the commitment of the budgetary spending to ultimately get—you can deal with one, and then you can try to work toward it with your budgetary decisions, and another thing that this might do is, that if you get your larger space goal, then it's going to help you in your closer-term planning for space station, and the transportation system, and the science objectives, and where research money could best be used. So it's all going to flow together.

Mr. MORRISON. Absolutely.

Mr. NELSON. Another benchmark, Mr. Walker, is 1992, the International Space Year.

When Bob and I took the committee to Moscow in October of 1985, we talked to the President of the Soviet Union about International Space Year, 1992, encouraged him to be thinking about the same thing. We came back, and we wrote our NASA authorization bill, and we put that in it, so that's another benchmark that we could look to.

Yes, sir.

Mr. ROBERT WALKER. May I add in for just a couple of minutes?

Mr. NELSON. Absolutely.

Mr. ROBERT WALKER. I was here earlier when we talked about goals and a number of other things, and I think that that's very important, and I gather that the discussion has gone on, and I'm sorry I had to go to a couple of other meetings.

Let me suggest, though, that the word that we don't use very often in this discussion and I think we ought to discuss more often is "commitment," because there's a level of national commitment that has to be involved before we can set real goals. We have to know at what level the Nation is willing to commit to the—to space and space policy, and what I'd like to hear from this group, or if you can bring back to me some ideas, I'd like to know where this Nation would be at the end of the decades of the nineties if we made a level of commitment equal to the national commitment of the year 1965.

In the year 1965, we were spending 3.8 percent of the Federal budget on space. That would be the equivalent of spending $40 billion today on NASA. We were, as a Nation, spending 3 percent of our gross national product on space activities in the mid-sixties. That would be the equivalent of space spending on the order of $120 billion today. Now that's from all sectors; that's military, NASA, commercial, all of that.

But it seems to me that before politicians can sort out what we have to do and what the goals should be, we have to know what it is we're capable of doing, and the reason for picking those kinds of figures is because at one point this Nation said, "That's what we're capable of doing." Today, I mean what we do is, we play around at the edges. All of us set goals based upon what we think is realistic for NASA to get or what we think is realistic for the Nation to do.

Well, you know, at some point it was realistic for us to commit 3 percent of the gross national product to this enterprise; at one point, it was realistic for us to commit 3.8 percent of the Federal budget to this enterprise; and it would be very useful to find out from the experts in the field where we would be in the year 2000 if we spent the whole decade of the eighties making that kind of commitment to space activities.

My guess is that we would all of a sudden find that there are real goals and real things that would—that, as a Nation, we could achieve if we were willing to make a commitment of that kind. Is it possible to take a look and come back to us and say, "Yes, if you were really willing to spend that kind of money, this is what could be achieved in a ten-year period"?

Mr. MORRISON. Mr. Walker, I think yes, obviously, that that's possible. For better or for worse, our organization is not the one to handle that, because we have engaged in this space policy study and we are winding up. Our report is due in April, and the prognosis is that we will go on to other things and not stay in the space area.

What you are pointing up is that at one time we had a space policy that drove the budget policy and not, as it has been ever since that time, the budget policy driving the space policy, and in order to do what you ask there would have to be some orientation as to where this analysis—in what areas this should go: should it go towards how far can we go in understanding the environment of the earth by the year 2000 if we put a lot of resources into that, or what are the areas you wish to analyze that, or what are the areas you wish to analyze. But I think that technically it can be done very easily.

Mr. ROBERT WALKER. You see, I am not sure of that, because I think what we have just done is raise the finite resources available. In other words, you know, if you say to NASA, "Instead of $15 billion, if you had $40 billion, what would we be doing different and what would we be able to achieve?" it seems to me that you might not have to target the study, that you allow people to dream a little bit and say, "Yes, if we had a real level of resources available to us, you know, here are a whole variety of things that we're not even thinking about doing at the present time, we don't even see as possibilities at the present time, that we might be able to get into and achieve. If we were capable of doing that, this is how much sooner we could bring on line some of the things that we are already talking about." That is what I would like to see us doing—if we were, as a Nation, investing $120 billion in this, what we could do.

I understand that maybe your organization isn't the place to do it. I have asked some other people to take a look at it. NASA is taking a look at it; the Library of Congress is taking a look at it; I'm trying to get some people involved. I guess I'm seeking here maybe some help in getting as many folks involved as possible to come back and feed back that information, because I think we could come up with some fairly exciting stuff if we knew what a real commitment would produce for us.

Mr. CHARLES WALKER. Mr. Walker, if I might, as a personal response to your question, based upon—based upon just my personal commitment to working in the arena that we call space, my personal interest in that area, I would say that just looking at the year 2000 in conceptual and a very general way, what we could do by that time, spending 3.8 percent of our national budget on space, what we could do might just begin to meet the expectations of the ten-year-olds that are going to be voting that year. I think the ten-year-olds that are now in our school system have great expectations. Quite honestly, more than one or two have written me about those expectations, and they communicate desires that, in all frankness, growing to adulthood, I think, tended to wash out of me as being expectations that I thought were possible, and I think that's too bad because the word that is necessary here is "vision," and we need to bring that back into the national debate and, yes, the leadership statements that this Nation seeks.

Your committee, Mr. Chairman, has already begun that on this side of the Hill. Leadership statements that haven't always been heard, to an extent that those of us who work in this arena and think in this arena, certainly want to see done. There has got to be much more of it. Those kind of visions will make the year 2000 a glorious place, I have to say, with regard to humanity and the benefits from our dabbling in the new ocean of space and in the new frontier that is there.

There is—just as a sidelight to that, Mr. Walker, I would point out that few people recognize, I think, or remember that the National Commission on Space, as the chairman brought up earlier this afternoon, conducted many public—public symposium and panel discussions in which the public was invited to share their visions of what humanity could be doing in space not just 20 but 50 years out, and this was conducted 5 years ago and more.

Some of those visions that I remember as having been noted include the fact that the public believed that not only could we do the following things in space but this country, in fact, was on its way to doing, if not doing, some of these things in space, and that included solving our nuclear waste problem by cheaply dumping highly contaminated sources of nuclear radiation into the sun, or certainly into deep space; even using space as a point of last embarkation, you might say, for the most desperate of public offenders, prisons in space.

The people have some very interesting perspectives on what might be done there. In fact, they look at space as a place to do business, a place to do the public good, a place to work, just like here on the ground, and that's been promulgated, I've got to say, by movies, by television, by works of fiction by some of our greatest authors, and the public believes that much can be done there, and I have great—a great sensitivity for the fact that the public, in fact, has more sense than any one of us as individuals.

I think a lot can be done there, and we really have to expand our vision of what can be done, and I have no doubts that, with time, those things, all of them, will happen.

Mr. **Robert Walker**. I think your statement about somehow that we lose the perspective of a ten-year-old at times is something that is very meaningful, because I think we tend to put artificial limits on ourselves and then think that only things can be done within those limits.

I mean, I must say, as somebody who works in this field, I am constantly amazed by people who tell us—tell me all the technical impossibilities of going to the moon in 1988, or 1989, or 1990, and I have to say to myself, "Twenty years ago, we went there; we've already been there as a Nation," and so on; "Don't tell me we can't go there, you know; don't give me all the technical problems. We've already proven we can do that, and what we have to have is some kind of level of commitment and a level of resources that allows us to do it the right way again," and we don't want to think in those terms because we think first of the resource limits and then try to measure the commitments and the goals to those, and I think if we're going to be successful we're probably going to have to reverse that a little bit so that at least when we limit the resources we know what we're leaving out.

You see, one of the things—one of the things that always drives the political process around here is, you set very, very high kinds of—kinds of numbers, and then you do what you can within it.

I mean, when we passed what I regard as a crazy bill last year on catastrophic health insurance, I mean it was premised on the fact that there were some 20 million people out there who needed this additional coverage. We ended up with a bill that is going to cover 18,000 people a year at some fantastic pay. But the idea was that what we were doing was addressing a problem for 20 million people.

Well, you know, we in this community need to begin to think in those terms too. We need to understand that, as we cut the resources, this is what we are losing, and that will make it far easier to argue on the Floor and far easier to argue for the goals if what we say is, "Okay, you think we're spending a lot of money here; we're not spending a lot of money, because this is what we had to leave off; this is what we are not going to be able to do as a nation, because we don't have enough money in this budget to do these things," and let people know what—what they have lost as well as what they are getting. Today, we only tell them what we're going to buy with the money, and not all of them are convinced are that that's the best thing to buy, and so we lose a part of the people who are even supportive of us, and, you know—reorienting the thinking would be very helpful.

What we need is the empirical data with which to reorient the thinking, and if you can help us with that, it would be much appreciated.

Mr. **Morrison**. Mr. Walker, you stimulated a recollection. One of the early steering committee meetings that we had—Dr. Frederick Seitz was on our steering committee, and he lived through the Great Depression, and he lived through the Second World War, and during the course of the deliberations of that steering committee he came up, he addressed the subject of vision and not limiting ourselves by saying the following: He said, "Look, during the Great Depression we convinced ourselves that we were a poor country, and we were a poor country. After the Second World War, we convinced ourselves that we were a rich country, and we were a rich country. We're the same doggone country."

Now there were economic bases that made some of those things, underlying bases, that made them true, but a part of the problem and a part of the solution is how you think about them.

Mr. **Robert Walker**. Thank you. Thank you, Mr. Chairman.

Mr. **Nelson**. Any further comments or questions from the committee?

Mrs. Morella, anything from you?

Mrs. MORELLA. Well, my problem is that I got here late, but I have the testimony here before me, and I'm curious about the concept of commercialization—who would be in charge, how you see it set up, and did you already address that?

Mr. MORRISON. Not specifically.

Charlie.

Mr. CHARLES WALKER. Mrs. Morella, we did discuss commercialization briefly, but in terms of who would be in charge, we view commercialization as a vital part of what the Nation needs to be about in space but not as a driver necessarily. There are activities, technological projects, programs that apply basic and newly learned science and knowledge, programs of this nature that are a must for the public benefit in a public and a national space program. From these activities will come applications and technology that, almost certainly, at some time, will be applicable to a commercial marketplace where private sector capital and investment can see and obtain a product that the public can buy.

But to force that kind of situation is probably—and I think history reflects this in terms of an attempt to, probably too early and in an erroneous manner, privatize or commercialize remote sensing capabilities—to push that kind of situation is probably erroneous and will result in an inefficient expenditure of public and in private investment, and I've got to say, I, myself, come from a program with McDonnell Douglas Corporation that, among other programs in the commercialization of space arena as a category of activity, we attempted to develop technology to be flown in space to purify medical materials. The technology was, in fact, refined and worked well, but because of the advent of genetic engineering here on the ground, in laboratories and pharmaceutical factories on the ground, the economics of doing it in space began to diminish. At the same time, the Challenger accident literally cut off all access to space. A business decision was made that any potential return on investment would probably take 20 years, and in the private sector that's not something that private capital is put into.

So there is a real need for stability in many arenas—public policy with regard to support of space programs, technology development, technology utilization; the availability of access to space, the launch vehicles to get there and to get back again; and the minimization of risk, appropriate policies that will allow for the insurance community to support the investment community in a way that the investment community is used to. Trying to change old habits in the commercial side just to go into space and do business there isn't really going to work.

Mrs. MORELLA. It's interesting that you comment on the stability, and that it will happen, and it should happen at the proper time, and you don't seem to have any fear that we could be holding back too much and therefore be—have difficulties with competitiveness from other nations.

Mr. CHARLES WALKER. No. In fact, we do state that technological as well as economic competitiveness is a driver for us to put in place policies, national policies, for support of research and development that will provide appropriate technologies for commercialization. Some technologies that we develop in our space program are not appropriate for the commercial sector to utilize, to invest in, but others are. If we can help in the national space effort in employing these technologies, demonstrating them, because many of them are very high risk, and only if demonstrated, in some cases, will the private sector say, "Now I feel like there is a minimal amount of risk and I can invest in it."

Those kinds of things would be appropriate activities, and others, as we talk about in our paper, for the Federal Government to work with industry in assessing, defining what it is that needs to be done to enhance the—the feeling of the private sector that it not only wants to invest but will see some return on that investment, and those kind of activities certainly have to take place for this Nation to see some satisfactory return from space activities that will influence positively our problems in a competitive arena, in the economic arena.

So there is participation there for the private sector, but we have to do it in an intelligent manner.

Mrs. MORELLA. Did President Bush ask for your opinion before he did his budget address that we're going to hear tomorrow night?

Mr. MORRISON. Don't we wish.

Mrs. MORELLA. Do you know what he's going to say? I mean have you heard anything on the space program?

Mr. MORRISON. No.

Mrs. MORELLA. Thank you. Thanks, Mr. Chairman.

Mr. NELSON. Any further comments or questions?

[No response.]

Mr. NELSON. I would just close out our hearing today with these comments. I have in front of me a copy of—Bob, I want you to hear this.

Mr. ROBERT WALKER. Yes, sir.

Mr. NELSON. This is part of what came out yesterday from CBO—that thick—about all the drastic options throughout the budget, that if you want to make major slashes in the budget, that you have different alternatives. It goes to the Budget Committee. They do this every year, and they're usually the big ticket kind of slashes, and, of course, one thing that it puts in every year is a big ticket to slash, is the space station.

Now the commitment of the space station has already been made in the battles that we've fought over the last couple of years, particularly last year, but just for the record I think it's important to respond, since this is a formal presentation, albeit just one of that many, before the Budget Committee.

Basically, the proposal to cancel the space station flies in the face of everything that we've said today, and I let the record of this committee hearing speak for itself. Our space program is strongly supported by the significant, almost unanimous sentiment of the American public, and it has been responsible for an extraordinary, positive economic balance of trade, so that if anybody ever seriously considered the elimination of the space station, you'd be looking at the waste of over a billion-dollar investment, you'd be looking at that interim goal that we talked about, the waste of it, toward a long-range goal of exploring with humans the heavens, that those teams of thousands of scientists and engineers that are already in place, ready to start bending the hardware that they're going to do this year, would be at risk.

The question of the international cooperation, which, in and of itself, is not a goal in the space station but is a by-product of a national project set by the United States, that would be at risk. The initiative, the ambience, the esprit de corps of America on the comeback from a major national disaster would be significantly diminished, and then the loss of our only means for carrying out our future space program in human exploration, and experimentation of certain kinds of science in the near term would be considerably threatened, not to speak of the trained scientists in the field, the loss of scientific world-wide leadership, and crippling of science education initiatives.

So, I mean what I just said really almost go unsaid, but I figure I'd better say it so it will be on the record in response to the document that was released yesterday.

Mr. ROBERT WALKER. And besides, it would be just plain dumb.

Mr. NELSON. So sayeth Mr. Walker.

Thank you, and good afternoon.

[Whereupon, at 3:55 p.m., the subcommittee was adjourned.]

REVIEW OF MAJOR SPACE PROGRAM STUDIES AND RECOMMENDATIONS MADE TO THE BUSH TRANSITION TEAM

THURSDAY, FEBRUARY 9, 1989

House of Representatives,
Committee on Science, Space, and Technology,
Subcommittee on Space Science and Applications,
Washington, D.C.

The subcommittee met, pursuant to call, at 9:41 a.m., in Room 2318, Rayburn House Office Building, Hon. Bill Nelson (chairman of the subcommittee) presiding.

Mr. Nelson. Today we're going to continue our hearings on the studies that have been submitted to the new administration. This is the time for new ideas and we're looking forward to seeing the new administration's new ideas on meeting the challenges of our space program.

This subcommittee has taken on a program over the last several years in trying to develop the strengths of the space program to advance the national agenda. We found that space offers a great resource for addressing problems in the environment, in education, in foreign policy, as well as science. So as we look forward, we can take this space investment and apply it into many different areas.

Now, I just want to give a personal little note here. When I met with the crew of Discovery after their successful launch this fall, Pinky Nelson, a member of that crew, had been a member of our crew on STS 61-C. One of the first things I had asked him about was what did the destruction in the rain forest look like, because in January of '86 it was a sad sight. It was painfully apparent that there was rampant destruction even from our platform in space looking back at the planet. And Pinky said, "Bill, it's so sad." He said, in the two-and-a-half years since we last saw it, he said the expansion of the destruction is so markedly changed. That's just one way that we can approach, in a Mission to Planet Earth, an ambitious program in the space program, of trying to understand the entire ecological balance, because there you have a perspective that you see the entire ecological system at once.

Now, in yesterday's hearing, we tried to focus on broad policy areas affecting the space program, and today we're going to turn to specific technical goals. For example, yesterday we heard about the high priority we should place on Mission to Planet Earth. The effects of global warming, ozone depletion, and other environmental changes will be felt within our lifetimes. We must act to apply every technological tool at our disposal to understand and then to try to correct these problems.

This committee in the past has supported a commitment to manned exploration to Mars. This is not only a long-range goal, but it is one that, as we venture out and explore the heavens and settle other bodies, it is almost an inevitable goal.

Three years ago, in October of '85, this subcommittee conducted an official visit to the Soviet Union to encourage civilian space cooperation with the Soviets. That's our report. We discussed at great length not only the manned Mars mission and the global change issues, but we also explored a host of other ideas. I never will forget a two-hour, eyeball-to-eyeball meeting in the palatial surrounding of the palace of the old czars in the middle of the Kremlin with the then President of the Soviet Union, former Foreign Minister Mr. Gromyko, eyeball-to-eyeball for two-and-a-half hours. It was intense. But we had a good exchange of ideas on a host of ideas that we could cooperate.

Now, one such concept that we may look at in the future is radioastronomy and the possibility of flying two independent radiotelescope antennas. This would allow scientists to add their data together and increase the resolution with which we view stellar objects.

So these cooperative programs are not only exciting scientifically, but they have the possibility of greatly benefiting the relationship between our countries.

The Bush administration today has a marvelous array of goals to choose from. This is a rare opportunity that few Presidents have had. Unfortunately, this President, with whom I visited with his Vice President, who will be the Chairman of the National Space Council, I visited with him yesterday. They come into a program that has come back with a resurgence that is back from the disaster but has a number of major decisions that need to be made and need to be made very soon, decisions with long-range effects well into the next century. And so it is with this background that we have formed this panel today, for our witnesses who have given a great deal of thought to these choices, and we want the benefit of their discussion.

So let me turn to our Ranking Republican Member, Mr. Sensenbrenner, for his comments.

Mr. SENSENBRENNER. I have no opening statement, Mr. Chairman.

Mr. NELSON. All right. Thank you, Mr. Sensenbrenner.

All right. We'll start with Mr. Logsdon, who is the Director of the Space Policy Institute at George Washington University. Mr. Logsdon, we welcome you. And Dr. McLucas, we're looking forward to having your testimony.

And may I encourage you, as I have promised my committee members, that we would not have witnesses read statements to us that we could read ourselves but, rather, share with us your ideas, and then we will get in a free, give-and-take discussion with you in a dialogue.

Please, Mr. Logsdon.

STATEMENTS OF JOHN M. LOGSDON, DIRECTOR, SPACE POLICY INSTITUTE, GEORGE WASHINGTON UNIVERSITY; AND JOHN L. McLUCAS, CHAIRMAN OF THE BOARD, QUESTECH

Mr. LOGSDON. Thank you, Mr. Nelson.

Last December 8th through the 10th, the Space Policy Institute at George Washington University and the Planetary Society cosponsored a workshop on "Developing the International Agenda for Space Exploration". We brought together 35 or so people from around the world on that topic. The meeting was very ably chaired by Dr. McLucas. I want to turn to him to present the findings of our workshop and our recommendations.

Mr. NELSON. Yes, sir.

Dr. McLUCAS. Mr. Chairman, I am always happy to appear at your hearings, and I've been here on a number of—I'm sorry, I forgot to turn on the microphone. I am very happy to be here at these hearings. I always enjoy appearing before you.

As John Logsdon has said, the conference that I will be reporting on was chaired by myself, but it was sponsored by the Planetary Society and the Space Policy Institute of George Washington University.

I want to cover the main things that happened at our conference, at least those that we agreed on, and maybe make a few personal observations in addition. And I'll count on Dr. Logsdon to fill in where I might have omitted something or made a mistake.

Well, this conference was a three-day conference, including about 35 people from the United States, Canada, France, Germany, and the European Space Agency, using the general title "Developing the International Agenda in Space."

The principal theme that we were operating on, our supposition, I think, was borne out in the sense that we reached certain conclusions which said we have major gains to achieve by going international in space. We have specific objectives that we want to reach politically, economically, and from a national security standpoint, that can be benefited by broadening the extent of our international cooperation in space.

Specifically, we said there are two initiatives which are immediate, which could be helped by further international cooperation. You have already alluded to the Mission to Planet Earth. That was the topic that we said there was a consensus on. All of us wanted to work that issue. The United States is gradually coming to recognize the importance of carrying out Mission to Planet Earth. The thing which has not been so widely developed is the international participation in that, and we said the only right way to do Mission to Planet Earth is to have a very broad international cooperative activity going on, because after all, what's going on in the environment affects all of us. I'll come back to that in a minute.

The second subject that we thought deserved immediate attention was the increasing Soviet presence in space, and the Soviet initiatives were mainly things that we applauded, but if we wanted to continue to maintain something called U.S. leadership in space, we should regard the Soviet presence in space as a challenge. Another way to identify it would be to call it an opportunity.

But whether the Soviets are doing good or bad things in space, they always seem to get our attention. If they're making a big military buildup in space, then we say the Russians are coming and we'd better get with it. If they're making a big buildup in civil space, as they are now, we say the same thing. U.S. leadership demands that we have an adequate response to whatever they're doing in space.

What are they doing? Well, they've done several significant things—and I won't dwell on them but just list them. First of all, they have been able to demonstrate that you can keep people in space continuously for a year. We have not done any such thing. Second, they made an important mission to Halley's Comet, stopping off on the way to Venus and dropping off balloons there, and revealed a definition of the composition, structure and probable future of Halley's Comet way beyond any conception that we had before. Third, they now have their Phobos satellite in orbit around Mars. They initiated two of these satellites on their way last year. One got in trouble, but they believe in redundancy. They sent two and one of them arrived.

The impressive thing to me about that was that that Phobos satellite carries space packages from 12 different countries, and if that's not international cooperation in space, I don't know what is. Many of the people that the United States has regarded as its normal partners in space are on board that Soviet spacecraft orbiting Mars.

In addition to what they've actually done, they have asked the United States to participate with them in doing more. For example, many of their scientists have suggested that we should cooperate more on Mars exploration, specifically Mars, and the United States has held back. I'm not quite sure why we have been so reluctant to participate with the Soviets in this.

It's not that we don't have a space agreement. We did renew the space agreement almost two years ago, and yet the steps that are proposed in there, in our way of thinking, are too timid, too slow, in moving into really important activities. So we think that the United States should regain space leadership in the only way which I know of that we can do, and that is internationally.

We don't recommend that the U.S. try to do everything alone. We recommend that the U.S. do more internationally. We have an excellent history in space. As far as international cooperative projects are concerned, we have done a thousand projects with 100 countries over 30 years, and I think it's redounded very much to our benefit.

Now our next big initiative is the space station, and I'm very happy that this space station was developed through an international approach. I consider Jim Beggs' contributions to internationalizing that space station as one of his best initiatives and probably the most lasting of the things that he did. So I look at the space program, and people talk about how it's been in disarray and so forth. It seems to me that, rather than saying we need more money and we need to reorganize and so forth, what we really need is leadership and direction.

Let me go back to Mission to Planet Earth. I think here is the obvious example where U.S. leadership can be decisive. Everyone knows that we have the technology to carry out Mission to Planet Earth, to explore all the things in our environment which we're concerned about, to tabulate the data over a long period of time, which will be needed before we can see whether some of these trends are temporary or permanent, all these things we're prepared to do technologically.

But, in order to do this with a reasonable expenditure of money, and in a reasonable time period, what we need is the cooperation of everyone on Earth who has identified this problem. And the number of people who are identifying it is growing every day. I understand the Brazilians are as upset as we are now about what's happening in the Amazon, and that perhaps they will reassess their subsidies which they're giving to people to cut down those trees when they think about what all the consequences are.

I think we ought to begin internationalizing by a step-by-step process, that we should engage in coordination of all the many things that are going on; that having proved our points to determine the value of coordination, then we will go into the next step, which is cooperation and, beyond that, to perhaps consortia that will operate some of these spacecraft and save money in the process and have data which is properly calibrated among all the different people who are collecting data.

The Mission to Planet Earth concept was endorsed by President Bush when he was a candidate for President, and so I think the step I would like to see now is, as President, I would like to see him endorse this concept. And then the next step, endorse the idea of totally internationalizing Mission to Planet Earth.

We could start out with some of the simple platforms. We can go to the whole concept of the array of platforms that are needed to carry that mission out. We start small and we work up gradually.

I would like to mention an initiative that is stressed in our report here, and in which I was involved last April, almost a year ago, in New Hampshire. An organization that I happen to chair, the U.S. Association for the International Space Year, working with NASA, brought together a conference there which we called Mission to Planet Earth. The name is becoming very popular, so we called ours the ISY Mission to Planet Earth conference. At that conference we had 17 nations' space agency representatives there and we agreed that Mission to Planet Earth was the mission in space that required the support of all these countries. I was very pleased that that happened. And we brought together there the top leaders of those 17 countries' space agencies where they saw for the first time the different activities that all these countries were carrying out and were planning.

I was very pleased, (a) that they came together, (b) that they saw the report that was collected by their working people of all the different satellites that were going to fly in the next decade. We found there were 48 satellites, all looking at the Earth, and many of them duplicating essentially the same types of activities. In our view, the good that could come by trying to coordinate this program better is that if you spent the same amount of money, you could spend less of it looking at the Earth and more of it analyzing the data which you collected.

In my 30 or 40 years of watching people carry out surveillance and reconnaissance and so forth, one thing that has struck me is that we spend 90 percent of our money collecting and 10 percent using, analyzing, deciding what should be done with all the stuff that was collected. So bringing that group together I think was a first step.

The Republican platform in 1988 talked about manned flight to Mars as an objective which we should mount. They talked about Moon exploration. Well, after exploring the Earth—I guess I'm a Mars man. I have here an article that was published a month or two ago talking about we ought to go to Mars, but we ought to join the Soviets in a cooperative attack on the problems of Mars exploration.

I think we should not stress Soviet cooperation at the expense of our allies. I don't believe in dropping our allies and going in for cooperation with the Soviets. We've got to do both. We should do them simultaneously, and I think our chances of pulling off successful missions with the Soviets are improved if we have other international partners in the same activities. It's much less likely that U.S.-Soviet cooperation would bog down if you had other partners there to keep things calm and cool.

We think that the White House should broaden their concept of cooperation with the Soviets. We should go in for bigger steps on these joint studies that the space agreement of 1987 calls for, and we should include not only the Soviets in those discussions but more partners. We think the fact that you engage in discussions does not mean you're going to have cooperative programs on every subject that was discussed, but you need to discuss a broad range of topics in order to find a few on which you see reasons to cooperate.

Now, the final point made in our conference I believe can be summarized very quickly. Mission to Planet Earth should be made a worldwide initiative; second, we should expand the U.S.-Soviet agreement on space cooperation, to engage in a broader range of potential joint cooperative activities; and third, we ought to make multilateral the working groups that we have that are looking at exploration of the solar system, rather than working only with the Soviets.

I would like to just mention in passing here a few of the documents that I brought along that I thought were important to the subject at hand. I have already mentioned our International Space Year Mission to Planet Earth conference which brought together the heads of the various space agencies and initiated, I hope, a broad exchange between NASA and NASA-like organizations in other countries.

I'd like to mention the talk I gave over at the Air and Space Museum just two weeks ago called Mission to Planet Earth, in which I talked about what I think the administration needs to do to improve the opportunity for this to go international. Specifically, I call in here for making NASA the lead agency to carry out Mission to Planet Earth. There has been some reluctance at NASA, I know, to take on that responsibility. I think we have to make that case and that NASA should be the lead agency.

The other point I make in here is that the President has said he's going to upgrade the authority of his Science and Technology

Adviser. This makes that point, saying that the most important thing that that person can do, man or woman, is to properly orchestrate the Mission to Planet Earth.

I wanted to mention one other paper here which I had called Envirosat, Envirosat being a concept of an international armada of satellites carrying out Earth studies. And finally, I wanted to mention—which I assume you all have—a submission that was made with the budget from OMB, and it's prepared by the Committee on Earth Sciences of something called FCCSET, the Federal Coordinating Council on Science, Engineering and Technology. This report was prepared under the direction of the President's Science Adviser and gives a good overview of all the different activities that are going on with respect to global change or Mission to Planet Earth and how that needs to be beefed up.

I think, Mr. Chairman, those are the points I wanted to make. Thank you.

[The prepared statement of John L. McLucas, with attachments, follows:]

EMPHASIZING THE INTERNATIONAL AGENDA IN U.S. CIVIL SPACE POLICY

Testimony to

Subcommittee on Space Science and Applications
Committee on Science, Space, and Technology
U.S. House of Representatives

February 9, 1989

On the results of a December 8-10, 1988 workshop organized by The Planetary Society and the Space Policy Institute, The George Washington University.

Testimony Presented By:
Dr. John McLucas, Workshop Chairman and
Chairman of the Board, Questech, Inc.,
Accompanied by Dr. John Logsdon,
Director, Space Policy Institute and
Advisor, The Planetary Society

EMPHASIZING THE INTERNATIONAL AGENDA IN U.S. CIVIL SPACE POLICY

On December 8-10, 1988, some 35 leaders and specialists experienced in space policy from the United States, Canada, France, Germany and the European Space Agency met in Washington, D.C., to discuss "developing the international agenda for space exploration". The meeting was organized by the Space Policy Institute of The George Washington University and The Planetary Society. An agenda for the meeting and a list of participants is attached.

This group of experts reached one clear consensus: SPACE INITIATIVES THAT INVOLVE SUBSTANTIAL INTERNATIONAL COLLABORATION CAN FURTHER MAJOR U.S. SECURITY, POLITICAL, AND ECONOMIC INTERESTS AND ARE NEEDED TO RESPOND TO TWO IMMEDIATE CHALLENGES TO THIS COUNTRY.

This first challenge is the rapid, potentially disastrous changes to the global environment caused by growing human activity on Earth. Space-borne instruments, Earth-based observations and studies of other Earth-like planets are crucial for a focused program now labeled "Mission to Planet Earth." This mission should be international in conduct and content, and deserves high national priority.

The second challenge is the effective and innovative Soviet initiative to build international relationships in highly visible programs of space exploration and so demonstrate the U.S.S.R.'s technical prowess and new international openness. With its Eastern and Western European partners the Soviet Union flew by Halley's Comet, deposited balloon payloads in the atmosphere of Venus, and is sending a spacecraft to explore Mars and its asteroid-like moon Phobos. The Soviets have in essence established a permanent presence of humans in Earth orbit, and continue to push back the frontiers of long-duration human flight. Future Soviet plans make international involvement in U.S.S.R. science missions a high priority objective. Their initiative, enhanced by the new atmosphere of glasnost, is focused on Western Europe and the United States, but includes Japan, Canada, Europe, South Asia and Latin America.

So far the United States has responded guardedly to Soviet overtures, while traditional U.S. allies are entering into new relationships with the U.S.S.R. It is in the interests of the United States to regain its prominence in international space science and exploration, thereby influencing the future direction of the world's space activities and reaping the many benefits of international cooperation.

In order to do this, the United States needs to build upon three decades of cooperative experience with its traditional partners, and particularly upon the recently created space station partnership with Europe, Japan, and Canada. Meeting participants agreed that all spacefaring countries--the United States, the Soviet Union, Europe, Japan, Canada, and other nations--should be involved in planning and interests and objectives, both around the world and at home, strong presidential leadership is required. That leadership is needed to focus current U.S. space activities and is more essential to their policy effectiveness than are increased budgets, altered institutional arrangements, or new international structures--all of which, however, will be needed.

The President-elect has already endorsed a Mission to Planet Earth, the purpose of which is to provide vital information for policy decisions affecting all aspects of the world environment and economy and the health of its citizens. But a U.S. initiative is needed to make that program international. An international Mission to Planet Earth would begin with coordination of operations and data collection for the more than two dozen existing and scheduled Earth observing spacecraft of many nations. The mission would expand to include polar platforms contributed by the the United States, Europe and Japan, and potentially the Soviet Union. Early in the 21st century, it could encompass coordination of geostationary spacecraft of the major space powers.

An important first step was taken when a NASA-promoted space agency coordinating committee for the 1992 International Space Year (ISY) adopted the Mission to Planet Earth as a primary ISY objective. In this and other forums the United States can more effectively encourage the Soviet Union to respond with specifics regarding its participation. The roles of Europe, Japan and other spacefaring nations, the participation of developing countries, and the need for altered or new international mechanisms could be identified in the context of an enlightened global initiative related to Mission to Planet Earth.

The ability of the United States both to take an active stance in responding to Soviet space science initiatives and to indicate future directions for the alliance-based space station partnership is limited by the lack of an exploratory goal that provides a cohesive focus for American efforts in space. A broad array of groups studying the U.S. civil space program have concluded that its single biggest deficiency is the lack of a coherent exploratory goal. Expanding human activity and presence beyond Earth orbit was added as a long-term objective of U.S. space policy earlier this year, but no compelling goal nor specific objectives have yet been enunciated to carry out that policy. The Republican party, in its 1988 platform, recommended that a "resurgent America, renewed economically and in spirit, must get on with its business of greatness. We must commit to a manned flight to Mars around the year 2000 and to continue exploration of the moon." All at the meeting agreed that Mars was the long-term goal for human exploration, although a specific strategy for getting there was not discussed.

However, there was a consensus on the need to link current U.S.-Soviet interactions regarding solar system exploration with interactions with U.S. allies. Two related White House actions seem required. One is to broaden the scope of current U.S.-Soviet cooperation to allow the conduct of joint studies and the consideration of more ambitious, collaborative missions, both automated and ultimately with human crews. The other is to imbed these bilateral discussions and studies in a broader multilateral context. This would build on the space station partnership and thus engage other spacefaring countries as well as the United States and the Soviet Union in defining the directions for space exploration in the early 21st century.

If there was one message that came from most participants in the meeting, it was the need to begin discussing multilateral partnerships in complex space undertakings as soon as possible. All countries are experienced enough to recognize that exploratory discussions of potential collaboration on future missions do not constitute on any side a commitment to either collaboration or to particular missions. But issues such as matching expectations, roles, and contributions in major projects; making national commitments on different time frames and through different political and budgetary processes; and developing a rational and consistent approach to questions of technology transfer can only be addressed on the basis of extended, frank discussions among potential partners. These discussions should not be only at the technical level; involvement by political officials at an early stage is essential. Many participants suggested that the international regime for Antarctic activities was a particularly useful model in developing a multilateral approach to human exploration of the solar system.

Based on the above considerations, the organizers of the meeting--that is, The Planetary Society and the Space Policy Institute of The George Washington University--put forth the following recommendations:

1. the United States should intensify its leadership effort to make Mission to Planet Earth a truly global undertaking. A presidential endorsement and active presidential support for this effort would greatly facilitate its success;

2. the U.S.-U.S.S.R. space cooperation agreement of April 1987 should be amended to allow for the conduct of joint studies of solar system exploration missions and possible future multilateral missions; and

3. the United States should take the initiative in organizing a multilateral U.S.-U.S.S.R.-Europe-Japan solar system exploration working group. This group would consider the most appropriate steps in a multi-decade enterprise of robotic and human exploration and expansion beyond Earth orbit and identify the synergistic roles that the major spacefaring countries, and eventually others of the world's nations, might play in that enterprise.

LIST OF PARTICIPANTS

"Developing the International Agenda for Space Exploration"

December 8-10, 1988

Lew Allen	Director, Jet Propulsion Laboratory
James Beggs	NASA Administrator, 1981-1985
David Bodde	Executive Director, Commission on Engineering and Technical Systems, National Research Council
Roger Bonnet	Director, Scientific Programs, European Space Agency
Joanne Clayton	Senior Staff, Aeronautics and Space Engineering Board, National Research Council
James Carpenter	Chairman, Space Issues Group, Bush Campaign
Alain Dupas	Le CNES; Centre d'Etudes des Relations entre Technologies et Strategies, Ecole Polytechnique, Paris
John Dutton	Dean, College of Earth and Mineral Sciences, Pennsylvania State University
Burton Edelson	Foreign Policy Institute, Johns Hopkins University; Associate Administrator for Space Science and Applications, NASA, 1982-1987
W. M. Evans	Deputy Secretary, Space Policy Sector, Ministry of State for Science and Technology, Canada
Daniel Fink	Former Chairman, NASA Advisory Council
Dietmar Frenzel	Director, Office for Space Programs, BMFT, Federal Republic of Germany

Louis Friedman	Executive Director, The Planetary Society
Gene Giberson	Assistant Director, Jet Propulsion Laboratory
Albert Gore	U.S. Senate
Sam Keller	Deputy Associate Administrator for Space Science and Applications, NASA
Marty Kress	Senate Committee on Commerce, Science and Transportation
John Logsdon	Director, Space Policy Institute, George Washington University
Tim Lynch	The Planetary Society
Hans Mark	Chancellor, University of Texas; Deputy Administrator, NASA, 1981-1984
Frank Martin	Assistant Administrator for Exploration, NASA
John McLucas	Chairman, NASA Advisory Council; Chairman of the Board, Questech, Inc.;
Michael Michaud	Director, Office of Advanced Technology, Department of State
James Morrison	Center for Strategic and International Studies
Bruce Murray	California Institute of Technology; Former Director, Jet Propulsion Laboratory; Vice President, The Planetary Society
Harvey Meyerson	U.S. International Space Year Association

Noreen Noonan	Chief, Science and Space Branch, Office of Management and Budget
Kenneth Pedersen	Associate Administrator for External Affairs, NASA
Herman Pollack	Space Policy Institute, George Washington University; Chairman, Task Force on International Relations on Space, NASA Advisory Council, 1986-1987
Ian Pryke	Head, Washington Office, European Space Agency
Brad Mitchell	Policy Development Staff, Office of President-Elect George Bush
Jeffrey Rosendhal	Space Policy Institute, George Washington University; Assistant Associate Administrator (Science), NASA, 1982-1987
David Rossi	Orbital Sciences Corporation
Richard Sade	Center for Space and Advanced Technology
Carl Sagan	Cornell University; President, The Planetary Society
Harlan Smith	McDonald Observatory, University of Texas
Richard Smith	Principal Deputy Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs, Department of State
William Smith	Staff Director, House Subcommittee on Space Science and Applications
H. Guyford Stever	Chairman, NAS/NAE Committee on Space Policy; Science Advisor to the President, 1974-1977

DEVELOPING THE INTERNATIONAL AGENDA FOR SPACE EXPLORATION

Ritz-Carlton Hotel
2100 Massachusetts Avenue, N.W.
Washington, D.C.

December 8-10, 1988

Co-Sponsors: The Planetary Society
Space Policy Institute, George Washington University

PROGRAM

Thursday, December 8

8:30 - 9:00 a.m.	Continental Breakfast
9:00 - 9:30 a.m.	**Opening Remarks** *John McLucas*, Workshop Chairman *Carl Sagan*, The Planetary Society *John Logsdon*, Space Policy Institute
9:30 a.m. - 12:30 p.m.	**U.S. Space Policy and International Cooperation** Chairman: *John Logsdon* o Status of Center for Strategic and International Studies Space Policy Recommendations - *James Morrison*, CSIS o Status of NAS/NAE Committee on Space Policy Report - *John Logsdon* o Status of Space Station Cooperation - *Richard Smith*, Dept. of State

- Status of U.S. - U.S.S.R. Cooperation
  - *Sam Keller,* NASA
- Planning for the International Space Year
  - *Harvey Meyerson,* U.S. International Space Year Association
- Reflections on NASA Advisory Council Report on International Space Policy for the 1990s and Beyond
  - *Herman Pollack,* Space Policy Institute

12:30 - 2:00 p.m. **Lunch** (Provided)

2:00 - 5:00 p.m. **The Tough Issues**

Chairman: *Bruce Murray,* California Institute of Technology; The Planetary Society

- Technology Transfer Issues
  - *Lew Allen,* Jet Propulsion Laboratory
- Developing Lasting Commitments on Different Time Frames
  - *Roger Bonnet,* European Space Agency
- Organizing for Multilateral Collaboration: Matching Responsibilities and Expectations
  - *Kenneth Pedersen,* NASA

5:30 - 7:00 p.m. **Cocktail Reception**

Friday, December 9

8:30 - 9:00 a.m. Continental Breakfast

9:00 a.m. - 12:00 p.m.

The Potential for Major International Initiatives

Chairman: *Albert Gore,* U.S. Senate

- Moon Initiative
  - *Hans Mark,* University of Texas
  - *Harlan Smith,* University of Texas
- Mars Initiative
  - *Carl Sagan,* Cornell University
- Earth Initiative
  - *John Dutton,* Pennsylvania State University

12:00 - 1:30 p.m.

Lunch (Provided)

- Informal Remarks on International Cooperation
  - *James Beggs,* NASA Administrator, 1981-1985

2:00 - 5:00 p.m.

Public Symposium at Dorothy Betts Marvin Theatre, George Washington University, 800 21st Street, N.W. (Seats reserved for workshop participants)

Welcoming Remarks
John Logsdon, Space Policy Institute

Keynote Address
"What Space Can Do for America"
Carl Sagan, The Planetary Society

Panel Discussion

- The Prospects for International Cooperation
  - *Bruce Murray,* Former Director, Jet Propulsion Laboratory (Chair)
  - *John McLucas,* Chairman, NASA Advisory Council
  - *Harlan Smith,* University of Texas
  - *Roger Bonnet,* European Space Agency
  - *W. M. Evans,* Ministry of State for Science and Technology, Canada

Saturday, December 10

8:30 - 9:00 a.m.	Continental Breakfast
9:00 a.m. - 12:00 p.m.	**Shaping the International Agenda: The U.S. Role**

Chairman: *John McLucas*

- Next Steps: Conclusions and Recommendations
  - *All*

Mr. NELSON. Thank you, Dr. McLucas.

We agree with you about making NASA the lead agency on this mission. That's been part of the problem. There's been too much spread of the jurisdiction. We need to focus—somebody needs to be in charge so that we can move out. I appreciate your comments there.

I'm going to deviate from the normal procedure and turn to our members so that they can have an opportunity for dialogue with you, and then what I'll do is sort of be the clean-up hitter and follow up with any questions that need to be later on.

Mr. Sensenbrenner.

Mr. SENSENBRENNER. No questions.

Mr. NELSON. Mr. Smith.

Mr. SMITH OF NEW HAMPSHIRE. Just one question. Dr. McLucas, you indicated, in terms of international cooperation, an agreement especially referring to Mission to Planet Earth, to use your language, start small and work up gradually. We all know the problems with international cooperation. We have trouble cooperating internationally on issues here on Earth, let alone going into space. Start small and work up gradually for me, will you? Just give me some idea of what you envision we ought to be doing and how we ought to do it.

Dr. MCLUCAS. Well, there's an example in the news recently where NOAA is talking with the French. Both of them are operating an Earth observation satellite system. Ours is called Landsat; theirs is called Spot. These systems are doing essentially identical things. One happened to have been developed a few years after the other.

We have a new Landsat which is proposed now, which would be better than the Spot and so on. So they're coming along more or less in parallel and doing essentially the same thing. Both claim to be commercial but are not really. Both losing money, both having to be subsidized by the government.

The fact that the Americans and the French are talking about a cooperative program makes all kinds of sense to me. I would love to see the Landsat system become an international program.

I draw on the example of Intelsat, where we put together a consortium, which started out with talks between the Americans and the British and then the French and the Germans and the Brazilians, and pretty soon we had a dozen countries that were interested. Now we have 115 members who are operating a system that satisfies the needs of everyone.

I think the same could happen in the Landsat type of case, and starting small means two countries get together and then they find a third country that's interested, and finally you have got a lot of people interested.

Mr. SMITH OF NEW HAMPSHIRE. In looking at some of these problems—I'm sorry I wasn't here in the afternoon yesterday, Mr. Chairman, when you went over these things. But in some of these, specifically the rain forest depletion that the Chairman referred to, I think most of us would agree that the jury is already in on that. The destruction of the rain forest, you know, in terms of biodiversity and so forth, are having—is a real problem. Some critics would say well, we don't need to send any more satellites up to find that out; we know it. What we need to do is get some type of international cooperation and agreement here on Earth to correct it.

I assume that is understood, that's a given, and that we're moving beyond that when you say international agreements in space, that that's certainly not going to detract from or take away from what we have to do here on Earth now to implement what we found out as a result of space technology; is that a fair assumption?

Dr. McLucas. I agree with your statement. As I pointed out earlier, I think we frequently spend too much time collecting data and not enough using it.

But on your question about starting small, let me give another example which may be more important. I don't know which is more important. But right now, there are all these satellites planned by different countries. These are not calibrated in relation to each other. So you'll have satellite data being collected by the Japanese, the Europeans, the Brazilians, the Chinese, the Soviets, the Americans, and each one will be wondering how to compare their data against the data the other people have.

The first step, it seems to me, is to get everything calibrated. So that's a small step. So when I say let's start with a small step, let's start with a small step where people can understand each other's data, and then, after that, you talk about cooperation on collecting the data and then, after that, maybe consortia of satellites rather than individually owned.

Mr. Smith of New Hampshire. In terms of international cooperation, based on your observations with the limited amount that we've had thus far in terms of space, what do you feel is the prevalent view among nations? Is it for one nation to focus on one project, or two or three nations to focus on one project, i.e., exploration of Mars and another one to focus on weather satellites, and another—or are we looking at a sharing of—you know, everybody putting technology input and receiving the technology output? What is—how are we—It seems to me focusing with a few nations on one project and sharing that, and focusing with another nation or two on another project and sharing that, might make more sense. It's just an opinion.

But what is your observation as to how that is occurring? Are we seeing a focus, or we seeing it more of a broad brush with everybody sharing?

Dr. McLucas. No, I think one point which came out in the development of the international space station was that the countries that were approached said they wanted to participate only if their activities could be identified. They want to be able to go back to their own people and say "you see that module up there that's carrying out that microprocessing work" or whatever it may be—materials processing, I'm sorry—microgravity is the term I was looking for. "That unit was built by us, and those experiments are done by our people." In other words, they wanted to be able to identify to their taxpayers the results that were being achieved in space. So you will see that there's a Japanese module in the space station. It's not just that the Japanese have x-percent, 10 percent of the space station. They've got something that's got "Japan" written on it, and the French and so forth will have the same attitude.

I think you have to start with something that can be identifiable, and that means that on this project maybe you'll have the Germans that are interested, on another project the British or the Brazilians or whoever. It seems to me that's the way it starts. It starts from self-interest in being able to show that I'm getting something important done in space. And then gradually you work into this broader ecumenical movement. But that takes time, effort, and maybe decades, before it all happens.

Mr. **Logsdon**. If I could add a couple of words to that, Mr. Smith, there really is no structure for this division of labor, of choosing objectives. I mean, there are some highlight objectives in space and all nations want to be identified with them for their own reasons. And so, you know, either we end up in a competitive situation, where everyone is trying to do the same thing, or we find a way of doing it together, sharing the costs, sharing the benefits.

Mr. **Smith of New Hampshire**. It seems like, though, there should be a division of structure if you're going to avoid that unnecessary duplication that Dr. McLucas referred to.

Mr. **Logsdon**. But that will not happen until nations begin talking together in some broad framework, which is precisely the kind of thing that the International Space Year is trying to create and precisely the recommendation of our workshop. That multilateral discussions on the big missions of the future is something that should be started now.

Mr. **Smith of New Hampshire**. You gentlemen feel positive about how it's moving, progress is moving along those lines?

Dr. **McLucas**. I'm very optimistic. We got more done at that conference in New Hampshire last April than I ever expected we would, and as I said, we had 17 nations there. That group has grown, the so-called SAFISY group. Space Agency Forum for the International Space Year, has now grown to represent 23 nations. And I think more nations will join and I think we're off to a good start. I hope you'll hear more about that from NASA witnesses. I think they may be scheduled already.

Mr. **Smith of New Hampshire**. In conclusion, Mr. Chairman, I might say, Dr. McLucas, you picked a good spot to have your conference. A very pro-space State.

Thank you, Mr. Chairman.

Mr. **Nelson**. Mr. Slaughter.

Mr. **Slaughter**. No questions.

Mr. **Nelson**. Okay. Mr. Tanner.

Mr. **Tanner**. In December this past year, the Secretary-General of the Soviet Union made a speech before their plenary session—this is the United Nations speech. And this was one of the comments. I'm translating into English from the Russian.

"The Soviet Union is also ready to cooperate in establishing an international space laboratory or manned orbital station designed exclusively for monitoring the state of the environment." That starts to get pretty close to Mission to Planet Earth.

I wanted to ask you for the record, can we approach this Mission to Planet Earth from a global undertaking and include the participation by all countries, not just the space-faring ones? And what are your ideas about that, Dr. McLucas?

Dr. McLucas. Well, I think you can approach it in a lot of different ways. I have tended to go the step-by-step route and thinking that international cooperation starts with a few people and builds up.

Now, if you look at the meeting that we had there in New Hampshire last April, we found there a number of countries who said the Mission to Planet Earth is important enough that we are willing to sit with you and exchange data, exchange ideas, make proposals, and see how it develops. They weren't willing to commit money to carry out international projects. What they were willing to do was to exchange data and ideas and talk about further cooperation. This business about calibrating sensors and so forth caught a lot of people's attention.

And so I guess I think that most of these things have to start small and work up, but that you open the doors—in other words, you have a free entry into an organization such as SAFISY. You don't say you can't get in unless you're willing to commit a certain amount of money and so forth. Anyone is welcome to come who wants to begin on that basis—sharing data, sharing ideas, exchanging reports, and planning future experiments.

Mr. Logsdon. Well, in addition, the countries that aren't active in putting payloads in space have two ways of becoming involved in something like Mission to Planet Earth. One is ground truth. I mean, the observations taken from space have to be compared to ground-based observations, many of which will be in the Equatorial countries, the countries not involved in space.

Again, as Dr. McLucas says, the point is to get data that can be used. So training, involving everybody in the use, analysis and use of the data, is not the province only of the people that are collecting it from spaceborne platforms.

Mr. Nelson. Well, I certainly agree. Your point about we've got to start somewhere and we get this kind of cooperation going on. And I'm looking on down down the future. You know, you could take just the space-faring nations and they could do this. But ultimately you want all other nations participating because it may not be a space-faring nation, i.e., Brazil, that you need considerable cooperation with. And maybe we need to look at the sociological, the economic factors. Maybe we need to use a little raw politics in our negotiation with them. Maybe we need to use our economic power as a lever in trying to, once we discover from our view from space what the specific data is, get this thing into an overall perspective of encouraging these other nations to participate.

Dr. McLucas. May I make one comment on that?

Mr. Nelson. Sure.

Dr. McLucas. I guess we tend to go to the extremes. We have people who say well, since this is going to involve many nations, it ought to go to the United Nations. Others say the United Nations has not done anything good lately so they should not be involved.

But take a look at the ozone problem that was tackled by the United Nations environmental agency, UNEP. There was a case where enough countries were concerned with the ozone issue that the UNEP was able to mount a significant initiative, with a lot of United States help, and with the British and a few others, so that there is an agency that ought to be used. The United Nations has a committee on the peaceful uses of outer space. They ought to be involved in this global change Mission to Planet Earth.

So it seems to me the record should not go by without saying that there is a role for United Nations agencies in this Mission to Planet Earth activity.

Mr. NELSON. What do you think the United States ought to do to try to establish, not leadership for the sake of leadership, but to get this thing moving?

Dr. McLUCAS. Well, I think the initiative we took in New Hampshire was a good example of what ought to happen. I think that the White House staff that deals with international matters should be engaged with Mission to Planet Earth on an international basis to the greatest extent possible. I think that NASA, which has a wonderful record of international cooperation, could move out and should work through this SAFISY organization that was created there and, through its normal bilateral contacts, just show a lot more leadership than they seem about to do right now.

Mr. LOGSDON. One further step that could be taken is to have the United States endorse the International Space Year in the appropriate international forum. In fact, it was the United States that blocked the UN endorsement of the idea, in a particular context, in 1988. If we believe that the International Space Year is an important step in broadening the basis for cooperation, the United States ought to be out in front in all appropriate fora.

Mr. NELSON. I didn't know that. I didn't know—There was a blocking of the ISY?

Mr. LOGSDON. In the United Nations, yes. It was in the context of responding to particular Soviet proposals for creating a world space organization within the UN framework, which is something the U.S. has opposed. But there ought to be a way for us to take the initiative in bringing the ISY to the United Nations in a way that endorses the concept so that the world community can get on with it.

Mr. NELSON. That's interesting, because a lot of that ISY came right from this committee.

Mr. LOGSDON. Exactly.

Mr. NELSON. We broached it in that meeting right there in the Kremlin, and we came back and that year put the ISY in the NASA authorization bill.

Dr. McLUCAS. Well, this shows the difficulty of arriving at the right working relationship with the United Nations. Here is the United States, who invented the International Space Year, balking at approving a UN resolution in this regard because of specific overtones of some Soviet initiatives there.

Mr. NELSON. Let me ask you, how immediate do you think the benefits of a Mission to Planet Earth would be? Are we going to see short term results?

Dr. McLUCAS. Well, yes. I think there will be short term results. For one thing, to take the ozone example, there's a lot of scare talk going around—and I noticed in your opening statement you said that global warming, we're going to feel it in a few years. Well, we don't really know that. Maybe that's not what you said.

Mr. NELSON. I didn't.

Dr. McLUCAS. But the point is—

Mr. NELSON. But a lot of people are. A lot of people are saying that, as you know.

Dr. MCLUCAS. That's right. And so I say we need more information, and we need it rapidly, so that people don't panic and start doing things that may be not helpful in the long run.

Mr. LOGSDON. But, Mr. Nelson, I think there's a broad challenge to governance involved in things like Mission to Planet Earth, because the primary beneficiaries are going to be our grandchildren. I mean, we're taking action now—

Mr. NELSON. Sure.

Mr. LOGSDON. —and making commitments now to sustain a livable planet for our descendants, not just us.

Mr. NELSON. Sure. You know, if it gets—next July, if it gets to 105 in Washington, D.C., like it did this past July, that might be another little encouragement for people that maybe there is global warming.

Let me ask you about this cooperation agreement that was made in April of '87, between the U.S. and the Soviet Union. Do you think it needs to be amended to allow for joint studies of solar system exploration?

Dr. MCLUCAS. I do. I think a lot of it has to do with interpretation. Many people say that because we now have a renewed agreement with the Soviets that, you know, we're sort of home free. But the agreement is quite specific and talks about things which I consider great but not great enough. In other words, that we ought to get more substantive, that we ought to carry out deeper studies, with more cooperation, so that we come to grips with some of these problems, rather than just skirting around the edges. Dr. Logsdon probably knows more about the details of the agreement than I do.

Mr. LOGSDON. Well, the agreement was amended at the 1988 Gorbachev-Reagan summit to allow for exchange of national studies of solar system exploration, which is a very cautious approach. We'll do ours separately, decide what we want, and then allow the other side to take a look at it, and then we can discuss our separate studies.

One problem is that neither the United States nor the Soviet Union has an approved solar system exploration program, and the bureaucrats of the world don't like talking about unapproved programs together. But as you say in your opening statement, Mr. Nelson, going to Mars is inevitable. Whether we go by way of the Moon or directly, we're going to do it as a planet, not in a head-on-head race with another country. We should recognize that, I think, and recognize the reality of the U.S. and the Soviet Union as the leading space-faring countries, but also Europe, Japan and China and others, that in the early 21st Century are going to be active in space, becoming part of the process and defining that mission now.

Mr. NELSON. All right.

Now, yesterday a number of our witnesses basically said directly on that point, that what we ought to do is set the goal that we're going to Mars with humans, and that we—that the goal ought to be there—and then we ought to build the budget to meet the goal instead of the reverse, letting the budget set what the goal is going to be.

Do you agree with their outlook? Set the goal, say you're going to go, and then work toward that goal within the constraints that find yourself in the budgetary constraints.

Dr. McLucas. I like that approach, yes. I think you ought to set the goal.

Mr. Nelson. So do I.

Mr. Logsdon. And it gives, as the Academy report that you heard about yesterday said, a vision to the manned program, to the space station, to a—it provides a long-term, sustainable rationale for why we are putting humans in space beyond Earth orbit, that we need to learn how to do that in the space station, with the assumption at some time in the 21st Century we're going to be leaving the immediate vicinity of this planet and going to other places. So let's recognize we're going to do that and get on with the job of preparing for it.

Mr. Nelson. Let me ask you your opinion, your personal opinion. Do you think the dialogue ought to be with the Soviets first about a manned mission to Mars, or should it be with our allies?

Mr. Logsdon. I have an opinion on that, so I'll start first.

I think that neither the European community nor Japan have done any systematic thinking on the issue yet. There are suggestions floating around, for example, in Europe, I discovered earlier this year, for creating a Paine Commission for Europe, a long-term definition of Europe's future in space. So I think that it has to start with the two countries that have had serious discussions of what this might be, and then broaden to engage the others that will by that time want to be thinking about that.

The long-range plan of the Japanese Space Activities Commission does include planetary exploration, and so the Japanese have begun to think, perhaps even more than the Europeans, about this sort of issue. So I think they're ready to participate in the discussions, but the two countries that have done the most systematic thinking clearly are the United States and the Soviet Union.

Dr. McLucas. I would agree with that, first of all, because the U.S. and the Soviets are the only two countries that have the capability to go to Mars now, and so they're the obvious ones to start, and then we should bring the others along.

Mr. Nelson. And I would only amend that—and I basically agree with you. I would only amend that to say, however, that the space station is integral to the exploration outward and, indeed, the partners are the partners in the space station, the allies. So that's another consideration.

I might underscore what you said, Mr. Logsdon, that maybe we do need something like a Mars commission to start focusing on this and pulling together ideas, instead of dealing just within the institutions that we have now—NASA, State Department, et cetera.

Mr. Logsdon. Well, we recommended in our report that the U.S. should take the initiative on a worldwide basis in organizing a multilateral working group on solar system exploration, if you want to call it multilateral, a global commission on human exploration of the solar system. That's the sort of thing we had in mind.

Mr. Nelson. Any further questions from any of the committee? Mr. Smith.

Mr. SMITH OF TEXAS. Mr. Chairman, thank you. I just had one brief question for the panelists.

And that is that the commercialization of space has been strongly endorsed by both Congress and the administration, and yet I understand that some of the commercial interests sees international projects as projects that bring rivals and competitors into the mix. Do you see that a problem? Is that going to in any way stifle the commercialization of space activities? Is it something that needs to be watched or is it perfectly acceptable and is not going to present a problem?

Mr. LOGSDON. Well, Mr. Smith, I was part of a task force of the NASA Advisory Committee a couple of years ago on international relations in space that addressed that question, the balance between competition for commercial payoffs and cooperation for the other goals in space. Our conclusion was that there was no area of significant conflict between those two objectives, that cooperation in helping manage the ecosystem of this planet and cooperation in exploring the solar system beyond the vicinity of Earth really gave no one particular advantages related to the commercial development of space.

Mr. SMITH OF TEXAS. Okay. I suppose you could even argue that by bringing others into the picture you might well come up with new developments that would benefit everybody. It might be that everybody benefits together more as a whole than they would individually.

Mr. LOGSDON. One of the things that this country has to learn is that we could profit from close collaboration with others. It's not a one-way street, even in the potential flow of learning and technology.

Mr. SMITH OF TEXAS. I tend to agree. Thank you.

Thank you, Mr. Chairman.

Mr. NELSON. Gentlemen, we appreciate it. It's been a stimulating discussion.

Mr. LOGSDON. Thank you, Mr. Chairman.

Mr. NELSON. I really enjoyed this and enjoyed yesterday. We wanted to stimulate some thinking and see what has been the advice, the best advice coming out, and we appreciate it.

Let's call up Dr. John Clark, Vice President of Public Relations—of Public Policy, I beg your pardon; we're going to put the public relations spin on the public policy—of the AIAA. He is the Research Chair at the Aerospace Engineering Department at the Naval Academy.

Dr. Clark, welcome. Share with us.

STATEMENT OF DR. JOHN CLARK, VICE PRESIDENT, PUBLIC POLICY, AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

Dr. CLARK. Thank you very much, Chairman Nelson.

I would like to welcome three members of your subcommittee that were not members at the last appearance that I made with your group last year—Mr. Johnston, Mr. Schiff, and Mr. Tanner. I am delighted to see the attendance so strong today. Also your new Ranking Republican Member, Mr. Sensenbrenner.

I'd like to begin by acknowledging the help and preparation of our testimony year after year by people that you very rarely hear or see. Two have come with me today and they're sitting right here in the second row, a Mr. Benson and Miss Pelton. Year after year, they're part of a very large process which goes too much unrecognized. Another member who is not here today, that you know well, Dr. Jerry Grey, you'll be seeing a lot of later this year with the rest of the testimony.

Mr. Nelson. I would invite Mr. Benson and Miss Pelton to join you at the table, if you would like.

Dr. Clark. It is rather lonesome up here. Why don't you come on up.

Mr. Nelson. You know that Miss Pelton was an intern with this subcommittee last year.

Dr. Clark. I do, indeed, and we were discussing this with your staff before the hearing and thanking them for training her so extraordinarily capably. Hi, Emily.

I also would like to acknowledge the help that we have from our very capable volunteer public policy committee. I will occasionally highlight the contribution of one of these members, and today I would like to highlight those of a mutual friend, Bob Cenker, the mission specialist from GE Astro.

I would also like to make a disclaimer that, although my present address is with the Naval Academy, I in no sense speak for them. This is a total totally separate activity on my part of a volunteer nature.

I should like to summarize our rather brief testimony even more briefly, so that we can get to the sort of valuable Q&A session that we've just enjoyed.

AIAA is known to you and defined in our testimony. We have made several rather recent studies which are germane to your inquiry today, which we have attached to the testimony. One of these, a one-page summary of our policy on the civil space program, a very important subtitle, "An Investment in America". Time and time again, we have all tried to emphasize the tremendous benefits to the public and to the taxpayer of the investments which we are making here which make it possible to do some of the necessary programs that we would all like to see this country associated with.

Probably the largest contributor to the economy of this country is in the area of aeronautics as opposed to space, but we can certainly see the precursor in the contributions which aeronautics has made because of the foundations going back many decades. There is no reason not to expect the contributions the present space R&D will make to be even more valuable to the taxpayer as time goes on. These we would appreciate you including in the record.

We have cited three possible broad goals, and the first has to do with what we've been hearing about much today. It's essentially the broad area of space science, the investigations to continue to get a better understanding of our Earth and our Earth environment and the whole solar system and the universe with these large observatories that are waiting for space on the space shuttle as we now see that back into business.

We, too, believe that this Mission to Planet Earth is of extraordinary importance. We would like to see more emphasis given to this. We would like to see, if possible, an acceleration of the effort to carry this out, and we would like to see NASA laying out such an accelerated program with a target in the mid-90's. Time may well be shorter than we even recognize.

What the final results will be are hard to determine. The expert disagreement on this speaks for itself. Clearly what we need is a stronger effort to make sure that we understand the nature of the snowball before it gets running down the hill too rapidly and gets out of control. And even the number of snowballs is a little bit unclear at this point in time. And perhaps with the greenhouse effect, snowball is the wrong direction in temperature, although even that is not certain.

Our second broad goal that we cite is the enhancement of competitiveness of our U.S. industry, a very elusive goal, essentially the area of space applications and space commercialization. I must say that an example that was used this morning on international cooperation carries with it it's own hazards if it is not done properly. I would like to go back to this proposed collaboration, if you will, between the French Spot Image and the American commercial company EOSAT Corporation. If the stories in Av Week in the last few weeks are to be believed—and I have reason to believe that they, as usual, are accurate in their assessment of the situation—one element of the U.S. Government, in NOAA, made an approach to the French without any knowledge on the part of the EOSAT Corporation or other elements of our own Government, including both the Department of State and the Department of Defense, and it was only very late in the game, within the last month, probably within the past few weeks, that any of these other obviously necessary players even heard of the approach, even though the American office of Spot Image had been aware of this since last fall.

I think this is a good example of the reason why we desperately need a central point for the civil space program. It's called obviously the Space Council, and you have been in favor of its reinstitution for years. So has AIAA. We would like to see it expanded to include aeronautics because of the increasing attempt, the obvious necessity, because the aerospace plane is one case where it's hard to say "is this of space or of the atmosphere". It's really both.

But whatever the details, it is obvious that all of your witnesses are telling you the same thing. There are all of these options. This is the time to sort these options and reach a consensus which will involve the executive and the legislative departments. There needs to be a coordinating point which does not represent the parochial interests of the various components as SIG space did. One cannot expect participants in that sort of an activity, who represent individual agencies, to be looking beyond their own parochial interests, unfortunately. The Space Council, under the chairmanship of the Vice President, can do precisely that. We have written to Vice President Quayle asking for some time to discuss these concepts with him. I hope that we will have that opportunity.

Our broad goal number three has to do with the extension of human presence beyond this permanently occupied space station to the Moon and Mars. The exact sequence and timing is something on which we need a consensus through the political process.

But there are essential precursors. These precursors have the names of CSTI, the Civil Space Technology Initiative, of which a very important component is Pathfinder, and the most important facility is the Space Station Freedom. You again have sensed the importance of not shortchanging the long lead time essential for basic research and development, which is a relatively small fraction of the NASA budget at any given time, and which is so important in determining which are the ways to proceed which will be the most productive and which are the dry holes of this particular oil patch.

Mr. NELSON. We certainly agree with you there, and we've made that very clear in the hearings that we've had thus far.

Let me ask you about your previous comment, about the National Space Council. What authority do you think the Space Council would have to implement policy?

Dr. CLARK. I think it should be a small, high-level staff group, small to get something done, high level for it to be listened to, staff because you can't have two entities actually conducting a program. It would be coordinating the work of the various agencies of the executive which will actually be doing the work.

Mr. NELSON. Okay. We've had some discussions about exactly that same thing, so we're in synch on that.

Dr. CLARK. Good.

Mr. NELSON. Please continue.

Dr. CLARK. Thank you. I'm just about finished with the summary of our testimony. One obvious factor that's been occurring in the space station program over the last couple of years within the political process has been a considerable amount of vacillation. There have been good reasons for the zigs and zags that that program has undertaken. But it seems to me that we have clearly reached the point where we've got to fish or cut bait.

I think that Jim Fletcher said something recently that we can wholeheartedly endorse—it's quoted in our testimony: "Restudy after restudy simply reinforces the conclusion that Station Freedom is well conceived...There is simply no room for further trimming or shaping or cutting. We either are going to build it, and build it right, or not build it at all."

So these many options—Let's pick a menu. Let's get these mechanisms in place. Let's select a menu. Let's implement them with the necessary budgets and actions, support them vigorously through the various processes and procedures. Pick a menu and, for heaven's sake, let's get going.

That concludes the prepared testimony.

[The prepared statement of Dr. Clark follows:]

AMERICAN
INSTITUTE OF
AERONAUTICS AND
ASTRONAUTICS

370 L'ENFANT PROMENADE, SW
WASHINGTON, DC 20024-2518

TELEPHONE
(202) 646-7400
FAX (GROUP 3)
(202) 646-7508
WRITER'S DIRECT LINE
(202) 646-

STATEMENT TO
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

ON

CIVIL SPACE PROGRAM ISSUES FOR THE NEW ADMINISTRATION

BY
JOHN CLARK, VICE PRESIDENT - PUBLIC POLICY
AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS
WASHINGTON, DC

FEBRUARY 9, 1989

INTRODUCTION

The American Institute of Aeronautics and Astronautics (AIAA) is a nonprofit professional society dedicated to advancing the art, science, and technology of aeronautics and astronautics and to promoting the professionalism of those engaged in these pursuits. We have a membership of 43,000 drawn from all levels of American industry, academia, private research organizations, and government as well as from numerous nations abroad.

The Institute has in past years published a number of position papers and assessments addressing various U.S. civil space program issues. The most recent of these, released in October 1988, was a one-page overview of broad civil space goals and suggested guidelines for funding decisions titled, "The Civil Space Program: An Investment in America." It was transmitted to then-President-elect Bush and his staff late in 1988, accompanied by a summary of "Aerospace Issues for the Bush Administration." The position paper and "The Civil Space Program" section of the issues summary are attached as appendices to this statement, and because they represent the AIAA's formal message on civil space to the new administration, we respectfully request that they be included in the record of this hearing.

The goals we have proposed in our position paper are broad ones; they encompass all the elements needed to maintain, at the very minimum, parity with other spacefaring nations. Within those broad goals, however, are a number of specific options that might be selected as focal points for the Bush administration's civil space agenda. Several such options are offered here as examples.

Broad Goal No. 1: Expand our current efforts to understand the Earth, the near-Earth environment, the Sun, the Solar System, and the distant universe.

A specific effort within this goal could be directed toward furthering our understanding of the major environmental changes that appear to be occurring in the Earth's biosphere due to mankind's activities, so that proper corrective action can be taken before these changes become irreversible. Such an effort has been identified by NASA as "Mission to Planet Earth." The first steps toward realizing the goal of understanding these environmental changes are already in process internationally under the International Geosphere-Biosphere Program, and domestically with development of instrumentation for NASA's Earth Observation System. NASA should be requested to lay out an accelerated program that addresses the objectives of "Mission to Planet Earth" by deploying the necessary systems no later than 1995.

Broad Goal No. 2: Enhance the competitiveness of U.S. industry in launch vehicles and space applications such as satellite communications, navigation, and Earth observations as well as in space-related services, information, and eventually products.

This statement addresses the elusive goal of commercializing space activities. There are several specific actions the new administration could adopt to meet this goal; they are implied in the space policy enunciated by former president Reagan on February 11, 1988 but have yet to be implemented. To achieve the goal of having U.S. industry competitive with foreign operators in all space-relevant areas for commercial opportunity, the U.S. needs to establish a new supportive working relationship between government and industry that involves major acquisition reforms such as long-term, multiyear government procurement of commercial goods and services to establish and sustain new markets, a broad menu of incentives to stimulate private-sector investment, legislation that encourages rather than discourages the formation of U.S industry teams (under governmental umbrellas where appropriate), and a strong U.S. government presence in support or international trade initiatives by U.S. companies. However, perhaps the most important single step the new administration could take toward achieving the goal of U.S. competitiveness in the various commercial space markets would be to unify the current disparate responsibilities for these activities (now divided among the Departments of State, Commerce, and Transportation and various agencies such as NASA, NOAA, and FCC) under a single policy-setting office such as the new National Space Council, whose motivations would be those of the nation as a whole rather than responsive to the needs of an individual provincial agency or office.

Broad Goal No. 3: Extend human presence beyond a permanently occupied Earth-orbiting space station to the Moon and Mars.

Opportunities for specific objectives toward accomplishing this goal are legion. The National Commission on Space, the NASA report "Leadership and America's Future in Space," the recent report by NASA's Office of Exploration, and many others offer extensive menus for missions that extend human presence beyond low-Earth orbit. The Bush administration can select any of these, with whatever degree of international cooperation appears practicable and desirable. But without the necessary precursor activity, any such selection of specific objectives will be no more than a hollow shell. The essential precursors to expansion of human presence into the Solar System include many elements, the most important of which are a vigorous, multifaceted technology advancement effort and development of the ground-based and space-based facilities needed to conduct such a program. The key technology programs are represented in the current NASA budget by the Civil Space Technology Initiative (CSTI) and especially the Pathfinder program; the most important facility effort is Space Station Freedom. A firm commitment by the Bush administration to major expansions in CSTI and Pathfinder would clearly establish the new president's recognition of space exploration as a major thrust of his administration, and cutting the Gordian knot of space-station program vacillation would establish his firm, no-nonsense stance on what is probably the most important single step in U.S. civil space development. As NASA Administrator James Fletcher said recently,

> "Restudy after restudy simply reinforces the conclusion that Station Freedom is well conceived...There is simply no room for further trimming or shaping or cutting. We either are going to build it -- and build it right -- or not build it at all."

These examples of how the new administration might proceed in setting civil space program objectives represent only one of many possible menus by which the broad goals stated in the attached AIAA position paper might be pursued. The most effective approach for the administration would be to select a menu of such objectives, implement them with the necessary budgets and actions, and support them vigorously through the various administration and legislative reviews and procedures.

We appreciate this opportunity to present our views on the new administration's approach to the civil space program, and will be pleased to answer any questions you may have.

Attachments: (1) Curriculum Vitae, John Clark
(2) The Civil Space Program: An Investment in America, an AIAA Position Paper, October 1988
(3) Aerospace Issues for the Bush Administration: The Civil Space Program, AIAA, December 1988

DR. JOHN CLARK

Dr. John Clark has had a distinguished career in space research and applications in both government and industry. Presently he is Professor of Aerospace Engineering at the U.S. Naval Academy in Annapolis, Maryland. Prior to this he was Director, Space Applications and Technology at RCA Astro-Space Division.

Beginning in 1942 at the Naval Research Laboratory, he measured electrical properties of the atmosphere and ionosphere using aircraft and sounding rockets. Dr. Clark joined NASA Headquarters in 1958, where he played a key role in formulating NASA's space science and applications program as Chief Scientist of that office. In 1965 he became Director, NASA Goddard Space Flight Center (GSFC). Here for eleven years he was responsible for the NASA worldwide networks, including Apollo manned lunar landing tracking and communications, the launches of over 100 Thor Delta Satellites and thousands of sounding rockets, and development and operation of scores of spacecraft, including the first geostationary weather satellite, the first Landsat Earth Resources Satellite, and the first orbiting astronomical and geophysical observatories. As a member of the Apollo 13 Failure Review Board he discovered that the electrically triggered combustion of teflon in liquid oxygen was the cause of the near-fatal service module explosion. During this period he was awarded the NASA Medals for Distinguished Service and Outstanding Leadership, and the NAA Collier Trophy for the Landsat Program.

At RCA Dr. Clark has completed such diverse tasks as inventing a Rain Echo Attenuation Compensation Technique (REACT) for airborne weather radars and planning the direct-to-home broadcasting satellite service in the Western hemisphere as senior technical advisor on the U.S. delegation to the 1983 ITU Regional Administrative Radio Conference in Geneva.

Dr. Clark is an elected member of the International Academy of Astronautics, Phi Beta Kappa, Sigma Xi, and Tau Beta Pi; and an elected Fellow of the American Institute of Aeronautics and Astronautics (AIAA), the Institute of Electrical and Electronics Engineers (IEEE), and the Explorers' Club. His earned degrees include the PhD in Physics at Maryland University and the Professional EE degree from Lehigh University. He is a licensed Professional Engineer in New Jersey. He is also Chairman, Direct Broadcast Satellite Association; Vice President-Public Policy, AIAA; Vice Chairman, Working Group on Satellite Broadcasting Matters, FCC Space Work Advisory Committee; Member, Board of Directors, Society of Satellite Professionals; Member, Frequency Management Advisory Committee, U.S. Department of Commerce; Consulting Editor, Space Technology, McGraw-Hill Encyclopedia of Science and Technology.

THE CIVIL SPACE PROGRAM: AN INVESTMENT IN AMERICA

An AIAA Position Paper

Approved by the
AIAA Public Policy Committee
and the
AIAA Board of Directors

October 1988

American Institute of Aeronautics and Astronautics
370 L'Enfant Promenade, S.W.
Washington, D.C. 20024
(202) 646-7400

A strong civil space program is a key element in economic competitiveness, international prestige, national security, and improving the human condition. Investments in the civil space program are investments in America. They promote economic growth and bring a high return in jobs and increased federal revenues to help support essential government services. Moreover, the civil space program is the most visible global symbol of American technological leadership and has long been one of the most popular federal programs.

Despite the current serious and valid concerns about the U.S. federal deficit, therefore, a national commitment to a healthy civil space program is necessary, along with the budget stability and growth needed to sustain it. Without such a commitment, the nation's position as a world power will suffer. Other countries, despite their own financial stresses, recognize the value of space investments and have made commensurate long-term commitments to broadly based space programs.

The U.S. has lost much ground in recent years from its former dominant position in virtually every area of space endeavor. However, American space leadership, with all it implies, can be reaffirmed if the nation makes a commitment to pursue the following goals:

1. Expand our current efforts to understand the Earth, the near-Earth environment, the Sun, the Solar System, and the distant universe.

2. Enhance the competitiveness of U.S. industry in launch vehicles and space applications such as satellite communications, navigation, and Earth observations as well as in space-related services, information, and eventually products.

3. Extend human presence beyond a permanently occupied Earth-orbiting space station to the Moon and Mars.

Prerequisites to the achievement of these goals include comprehensive research programs, broadly based technology advancement and demonstration efforts, long-term commitments to infrastructure development, construction, and operations, assured access to space via a full range of reusable and expendable vehicles, and substantial investments to update and improve education in science and engineering. Further, the importance of U.S. space activities to national well-being requires an independent, authoritative national space policy body with direct and timely access to the President.

The AIAA has recommended that a growth in civil space program support to about 1.3% of the overall federal budget is needed for reasonable progress toward achieving the proposed goals and their prerequisites. However, we recognize the powerful deficit-reduction pressures imposed on the formulation of annual budgets, and we acknowledge the unfortunate fact that these pressures may compromise vigorous pursuit of the above-stated goals. There are, however, overriding concerns that must be kept in mind when such compromises are being considered:

1. The space technology base is the foundation on which all future space activities and capabilities depend. Support for that base must not be allowed to decay, even though much of its payoff will come in the future.

2. Completion of current programs, both in science and in infrastructure development, should generally take precedence over the introduction of new programs. Once a program is approved and initiated, it should be completed on schedule and on budget. Program delays and stretch-outs always increase costs, often reduce capability, motivation, and accomplishment, and must be avoided.

3. Cutbacks in research, technology and advanced development spending must be avoided if they will result in substantially higher development or operations costs later. The goal is to minimize overall life-cycle costs.

The goals proposed herein do require a sustained budgetary commitment but are not costly relative to other federal investments in the nation's future. Most citizens recognize and applaud the commitment to the small fraction of the federal budget that supports the civil space program. The acknowledged urgency of reducing federal deficits must not impose a crippling constraint on the future generations who will reap the benefits of the space-program investments we make today.

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AEROSPACE ISSUES FOR THE BUSH ADMINISTRATION

December 1988

by

American Institute of Aeronautics and Astronautics
370 L'Enfant Promenade, S.W.
Washington, D.C. 20024

Aerospace Issues for the Bush Administration

The American Institute of Aeronautics and Astronautics (AIAA) is a non-profit professional society whose membership of 40,000 engineers, scientists, and students is dedicated to advancing the arts, sciences and technologies of aeronautics and astronautics and to promoting the professionalism of those engaged in these pursuits.

The Institute calls to the attention of the President-elect the following issues, which are of critical importance to the nation.

The Civil Space Program

The civil space program is a very visible symbol of our nation's ability to make scientific and technological advances, and its many successes have inspired our youth to pursue careers in vital technical fields. Our government must support these efforts with consistent budgets and strong leadership if the nation is to retain its position as a world leader.

The AIAA supports the goals advanced in the President's Space Policy of February 1988. We believe that the prerequisites to achievement of these goals include comprehensive research programs, broadly based technology advancement and demonstration efforts, long-term commitments to infrastructure development, construction, and operations, assured access to space via a full range of reusable and expendable vehicles, and substantial investments to update and improve education in science and engineering.

This is a crucial year for the space program, and the next administration must fund NASA's programs at a level commensurate with the need to achieve the President's goals. The AIAA recommends a NASA funding level of 1.3 percent of the federal budget;[1] growth thereafter must at least match inflation. This means a budget of at least $ 13 billion for FY 1990. Such a budget would cover the significant increases for NASA space programs mentioned in the following pages. While this is a substantial increase, it should be noted that while the federal budget has doubled in constant dollars during the last 20 years, NASA's has decreased by 15 percent.

A study by the Congressional Budget Office[2] shows that NASA's budget must increase significantly in future years if it is to carry out the ambitious programs prescribed for it in studies by the National Commission on Space, the NASA "Ride Report" and the AIAA.

In order to pursue these goals most efficiently we recommend that NASA produce a long-range Strategic Plan for the next 20 years identifying specific major programs and sub-programs needed to achieve it. Such a plan will greatly help to enhance planning at lower levels, to secure funding, and to focus the energies of NASA, industry and the nation on the great work that lies ahead.

The Space Station "Freedom" is vital to the nation's technical and scientific future, to the prestige of the U.S. as an innovative and exploring nation, and to the spirit of international cooperation in outer space. Almost every projection of the U.S. future in space has identified a permanently occupied space station as an essential element in virtually all space goals. The next administration must commit itself unequivocally to the space station by providing the necessary long-term funding and leadership, or the program will founder.

The Space Science program must be revitalized and then sustained at a level adequate to pursue the vigorous program of continuous exploration recommended by the National Academy of Sciences report.[3] The AIAA estimates that this will require funding for space science to be doubled over the next five years.

Space Applications programs have taken a back seat among NASA priorities in recent years. The AIAA believes that Communications Satellite R&D, Remote Sensing, and Space Processing programs need to be strongly supported within the NASA budget if this nation is to remain competitive in these fields. The AIAA estimates that the NASA budget in these areas will need to be doubled over the next few years.[4]

The condition of the environment is growing measurably worse every year. For instance, the destruction of the ozone layer and the heating of the biosphere as a result of industrial activities has raised worldwide alarms that the terrestrial environment is undergoing evolutionary change which may profoundly affect all life on Earth. A recent international report[5] has called attention to the potential for world climatic change brought about by injection of industrial gases into the atmosphere and calls for a considerable increase in global monitoring activities. Remote sensing from space is the key factor in global monitoring.

An earlier NASA report outlining possible future initiatives for the agency has identified a Mission to Planet Earth, which proposes to establish a space observational system for monitoring global change.[6] The data from such a system, along with Earth-based observations, would be used to understand and eventually predict changes that are occurring in the atmosphere and on Earth. The system requires the involvement of many agencies, such as NOAA and NSF, and those of other nations. The AIAA strongly endorses this program and urges the new administration to give it a high priority.

The purpose of NASA's Space Research and Technology (R&T) program is to provide the agency with the basic technologies for achieving its goal of pre-eminence in civil space activities. Unfortunately, NASA's supply of basic technologies has been seriously depleted as a result of a 75 percent funding reduction in the space R&T budget from its peak period in the mid-1960s. This deficiency has been recognized by such bodies as the NASA Advisory Council, the AIAA, and the National Commission on Space, who have recommended that funding in this area be increased from 2 percent of the NASA budget to 6 percent. NASA began remedying the problem with programs such as the Civil Space Technology Initiative in FY 1988 and the Pathfinder Program in FY 1989.[3] The Congress, however, has not been fully supportive of these initiatives and reduced NASA's Space R&T budget request by 25 percent for FY 1989. The AIAA strongly urges the new administration to support substantial increases in Space R&T until funding reaches the desired level.

The Commercialization of Space Activities is a desirable goal. It must be recognized, however, that American industry is often competing with foreign government-supported industry when it endeavors to commercialize space technology. The European Space Agency's Ariane launch vehicle now launches more than 50 percent of all commercial payloads in a worldwide market where we once stood alone. In addition, the Soviet Union and the People's Republic of China are attempting to enter the commercial launch field, and Japan will soon follow. Coupled with the overall expense and risk of space activity, this foreign-government-supported competition requires the U.S. government to back U.S industry by funding research and development, helping to open markets and promote fair-trade practices, purchasing products and services wherever they are commercially available, and generally providing a more cooperative overall relationship with industry.

International Cooperation in space must be encouraged and expanded in order to minimize duplication of effort and wasteful competition and to increase the sharing of knowledge. Space science programs are particularly amenable to cooperative ventures, as science has traditionally been an open enterprise involving few problems of technology transfer or compromise of competitive advantage.

An outstanding example of the benefits of cooperation is the Space Station program, in which Canada, Japan and Europe are contributing over $7 billion to help all partners realize the emerging benefits of space. Another will be the NASA Mission to Planet Earth, which will help us understand and predict global change. The benefits contributed are not only financial but also new ideas and technologies of which no nation has a monopoly.

It is too early to endorse an extensive U.S./Soviet cooperative effort such as a manned Mars expedition, but a graduated increase of West/East cooperation in space activities, tied to a commensurate warming of political and economic relations, seems prudent.

The administration should recommend to the Congress that NASA operate with multi-year funding in order to ensure continuity, efficiency, and economy of federal expenditures.

National Security

As a technical society the AIAA is especially mindful of the importance of science and technology to maintaining the nation's defense capability. The DOD's technology base programs provide the knowledge to produce new weapons and other systems required for giving the U.S. qualitative superiority to counter the numerical lead of our adversaries in many military systems. However, funding for the technology base has decreased greatly from its peak period in the mid-sixties, when it represented almost 25 percent of all research and development. Today it is less than 8 percent of R&D. In addition, studies indicate that our nation's qualitative superiority is declining in many areas. The AIAA therefore recommends a 3 percent real rate of growth in funding for technology-base programs in the foreseeable future.[7]

Independent Research & Development (IR&D) by industry also plays an important role in strengthening the nation's defense technology base. Such work is currently chargeable to corporate overhead on government contracts.

However, according to the Defense Science Board,[8] problems in this area "are reaching crisis proportions" as a result of changes made in the defense acquisition system, and a Senate Armed Services Committee study indicates that IR&D expenditures are indeed declining. The AIAA believes that IR&D is a very valuable complement to the DOD technology base program and that steps must be taken to prevent the erosion of this important resource. Most important, efforts to include IR&D as a line item in the DOD budget or otherwise impose a cap on IR&D spending should be strongly resisted.

Research for the Strategic Defense Initiative (SDI) program must continue at levels sufficient to support sound decisions on eventual system deployment and to provide accurate information on performance, producibility, affordability, and effectiveness. Many of the space technology advances needed to support the SDI program are derived from ongoing R&D efforts which are important in their own right. Any modifications made to the SDI program must not weaken those efforts.[9]

The AIAA recently held a workshop on the technologies involved in the research, development and deployment of strategic missile defense systems and concluded that if the technical issues identified by the assessment continue to be addressed, a survivable strategic missile defense system could be designed and deployed. The assessment drew no conclusions regarding the affordability of the system, which is a decision for the executive and legislative branches to make.[10]

The Defense Space Program, though virtually invisible to the public, has provided enormous benefits to national security through improved surveillance, intelligence, navigation and communications. These systems help fulfill the principal defense mission of keeping the peace by forewarning us of potential aggressive actions of our adversaries and by greatly improving the economy and efficiency of many operational systems required to keep our armed services ready and able to carry out their missions. Knowledge of the potential capabilities of these systems also contributes to keeping aggressors at bay. These important military programs should continue to receive strong support.

Economical access to space is one of the principal factors allowing us to exploit the capabilities of the space regime. While much progress has been made, greater cost reductions are possible through research and development in such programs as the joint DOD/NASA Advanced Launch System (ALS). The ALS promises very significant economies in space operations through reductions in launch and payload costs and increased reliability with the development of a new family of launch vehicles.

The National Aerospace Plane Program (NASP) is an important research and development project being undertaken by the Department of Defense with major research assistance from NASA. The program is aimed at developing a hypersonic research vehicle, the X-30, with the purpose of demonstrating the technologies necessary for building a single-stage-to-orbit craft that will have many revolutionary defense and civil applications. Among these may be a next-generation space launch vehicle that could potentially lower launch costs by a factor of ten below those of the Shuttle. Such a vehicle is envisioned to take off and land on conventional runways and burn low-pollution hydrogen fuel.

Many nations have begun programs for developing next-generation launch vehicles. The Japanese, for example, have a program that calls for the flight of a prototype vehicle similar to the NASP by 2006. Perfection of this technology will entail considerable resources and unwavering government support if the U.S. is to be a leader in this field.

AIAA concluded in a recent position paper that foreign technology is rapidly reducing our lead in military aircraft technology.[11] The Soviet Union's MIG-31 Foxhound aircraft, for example, is reported to rival the F-15 in performance, and their production capacity has enabled the Soviets to field it in greater numbers. The Institute recommends that military aeronautical research be increased by 25-50 percent within 3 years to meet foreign competition.

In addition, we recommend that the government undertake efforts to streamline military aircraft and equipment procurement practices to reduce significantly the time required from concept to prototype development. Modifications should include simplifying R&D procurement practices; multi-year appropriations; placing primary emphasis on technical merit in contracts; increasing readiness to fund innovative high-risk, high-payoff proposals; and encouraging industry cooperation in R&D both among private sector companies and with the government and universities.

Finally, the government should improve the process of formulating military aircraft design and operational requirements, using the "require to cost" principle and more intensive, shorter front-end design studies and testing (no more than one or two years before deciding on a prototype design).

The AIAA, many of whose members are deeply involved in defense-related matters, recognizes that a major war, fought with nuclear and/or modern conventional weapons, is capable of unprecedented devastation. Avoidance of the political, military and other conditions which might bring about such war therefore should be among the highest priorities of the government. The AIAA urges the government to pursue timely, serious and continuing discussions which will lead to equitable and verifiable controls over the number and types of weapons deployed by our adversaries; set the stage for subsequent balanced and verifiable reductions in overall force levels; and prevent proliferation of nuclear weapons and technology to the maximum extent possible.[12]

Civil Aeronautics

NASA's Aeronautics program must be significantly enhanced to take advantage of the major benefits inherent in the great advances that are now possible in this field. Aeronautics is one of the few industries in which the U.S. still leads the world; however, we cannot afford to become complacent in the face of aggressive, increasingly effective foreign competition.

The AIAA has concluded that the aeronautics policy and goals set forth by the President's Office of Science and Technology Policy in 1985 and 1987 are sound, but that insufficient action has been taken to implement them.[11] Funding (in constant dollars) for NASA aeronautical research and technology is less in 1989 than it was in 1980 even though opportunities are great, research costs are rising, and the competition is increasing. The AIAA therefore recommends that the NASA aeronautics budget be doubled and that the number of research personnel be increased if possible by 50% within three years. This would raise the funding applied to aeronautics programs within NASA from $400 to $800 million, or about 7 percent of the NASA FY 89 budget. The Institute believes that such an investment will more than pay for itself by adding to economic growth, increasing favorable balance of trade, and creating new jobs for Americans.

The nation's air traffic control system is reaching its saturation point and will not be able to meet the projected continuing growth of demand into the next century while maintaining acceptable levels of safety. The administration must give its full support to the enhancement of this system and its personnel. A complete overhaul and substantial expansion of the Federal Aviation Administration's research and development program is critically needed to prepare for the expected demand growth.

Scientific & Technical Education

A recent congressional study indicates that the nation's educational system is doing a poor job of preparing our youth to enter technical fields.[13] Nothing is more important to the long-term health of our nation than improving the teaching of scientific and technical subjects, from elementary school through graduate education. The federal government needs to give this area much greater support. Without it, our nation is destined to undergo economic and social decay, and the deterioration of our national security will follow in short order. The government must act to create high standards of technical education throughout the country, with both financial support and dedicated leadership.

Science and Technology Policy

The country needs scientific and technology policy advice at the highest level of government--the White House. The President should appoint a leader in the science or engineering field as soon as possible to head his Office of Science and Technology Policy. This Science Advisor must have direct access to the President and be given broad latitude in creating an advisory structure that will provide him directly with the best available counsel on major issues such as education, environmental affairs, and federal support for science and technology programs.

We also endorse the creation of a National Space Council, to be chaired by the Vice President and to include NASA, the Secretaries of Commerce, Defense, Transportation, State, and other relevant agencies. The purpose of the Council will be to develop, coordinate and recommend policy at the highest levels of government. We believe that the Council's charter should be expanded to cover aeronautics, as did its predecessor, to give this important field the leadership and coordination its outstanding contributions merit.

The Aerospace Industry

The aerospace industry is one of the largest and most productive industries in the United States. It employs 1.3

million people, its sales in 1987 were valued at $ 112 billion, and it has a backlog of orders totaling over $157 billion. Its exports increased by 15 percent in 1987 to $25 billion, and it contributed over $16 billion to the U.S. positive trade balance in aerospace products, leading all other industries. It conducts over 75 percent of the government's aerospace research and development, and it sells over 60 percent of its products to the government.

The Defense Science Board and the President of the National Academy of Engineering have in recent statements[14] observed the waning competitiveness of the nation's industrial base and have urged new policies to counter the negative trends. While the aerospace industry still leads the world technically and economically, it is vulnerable to foreign government- supported competition, which has caused a decline in its share of the market from 79 percent in 1970 to 73 percent in 1985. If the industry is to remain strong, the government needs to provide an environment in which it can continue to flourish by addressing issues of capital investment, technology transfer, support for research and development, trade policy, and the strengthening of scientific and technical education at all levels.[15]

Conclusion

The resources that the government spends on aeronautics and space activities and other scientific and technical programs are an investment in the nation's future growth. Not only do they create the technological progress that enhances the nation's ability to address urgent national priorities such as defense and the environment; they also generate the economic growth, jobs, and revenue needed to diminish the nation's budget and trade deficits. Such investments are also necessary for producing the resources to fund the ever-growing entitlement and other programs that make up a compassionate and balanced national policy.

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(8) Technology Base Management, Defense Science Board Summer Study, 1987.

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(11) Aeronautics Policy, An AIAA Position Paper, December 1987.

(12) AIAA Position on Arms Control, January 1984.

(13) Educating Scientists and Engineers, Grade School to Graduate School, Office of Technology Assessment, U.S. Congress. June 1988.

(14) News Report, National Research Council, p.11, November 1988. Defense Industrial & Technology Base; Task Force Report, The Defense Science Board, November 1988.

(15) Campaign 88, An Aerospace Perspective, Aerospace Industries Association, 1988.

Mr. **Nelson**. Thank you.

Do you have any specific initiatives that you think that NASA should take on supporting science and technical education?

Dr. **Clark**. We have long been of the view that support of scientific and technical education is one of the most important things which this country can do to enhance competitiveness. It's one of the cornerstones and certainly one of the cases in which we are sadly lacking.

We've all seen the plethora of studies that have been completed recently. I think, to me, one of the most impressive was one having to do with the mathematics capability of high school students the world over in some uniform tests. I don't remember the exact numbers—and they're not really important. What was important is that I believe South Korean children were number one, and their self-perception, said that only about 30 percent of them believed that they were good at mathematics when, in fact, they were tops in the world.

The United States mathematics students were something very close to the bottom, and yet some 78 percent of them believed that they were quite competent. Our expectations need to go a lot higher than they are. We apparently are in the very difficult and dangerous position of not even knowing what we knoweth not. A very dangerous situation.

Now, to your question, I think that in the heyday of the Apollo program, during the decade when President Kennedy made the commitment to land a man on the Moon and return him safely, there was a real excitement among the young people of our country and we didn't have to try to convince people to study. They wanted to because they wanted to take part. I think this is one of the most important contributions that such an inspirational, high-visibility program should make to the country. It's one of the reasons why we need understandable goals which have at least visible short-term milestones as well as long-term hopes and expectations.

Mr. **Nelson**. You're exactly right. I was part of that era. And even before that, I had the privilege of growing up in the shadow of Cape Canaveral in the Fifties, when everything was starting. That was a pretty exciting time. And I never will forget when we were shocked out of our pants when the Soviets put up Sputnik. And then we tried and tried with that Navy Vanguard and couldn't get it up. And then that's when Dr. Von Braun came in with the Army Redstone and put up Explorer I. That was an exciting time.

Dr. **Clark**. It was an exciting time, and it's clear that we should have given the go ahead to both Vanguard and Redstone. We could have been first in space with Redstone and the Vanguard technology could have come along in a somewhat more deliberate and hopefully more successful way.

Mr. **Nelson**. Members of the committee?

Mr. **Smith of New Hampshire**. Thank you, Mr. Chairman. Let me just follow up.

I know the Chairman has had at least one, if not two, meetings recently with the Vice President regarding this National Space Council. Obviously, without going into names, could types of people—some are obvious—but I think, to me, if we're going to move this—have a space program and have a—and look to the future and build and do what we all want to do, hopefully all want to do here in America, that I think the National Space Council is critical.

I assume that you would agree, that probably the NASA director ought to be on that council—

Dr. CLARK. Absolutely.

Mr. SMITH OF NEW HAMPSHIRE. And the Vice President, of course, is the head of it.

Dr. CLARK. Yes.

Mr. SMITH OF NEW HAMPSHIRE. Let's move from there, without mentioning names, personalities. I mean, I'm just talking about—we've got to have the political might there. We also have to have the technical. The statute is not really clear, as I understand it, on that. There is some room for maneuvering. So I think this is important, to set the tone for the next 10, 15, 20 years in space right now, because we are creating that council now, literally.

Dr. CLARK. I could not agree more, Mr. Smith. I was with NASA from its beginning in 1958, and when we had the Space Council chaired by Lyndon Johnson under President Kennedy, it was a very effective mechanism for coordination. It had very low visibility, which was appropriate for that point in time, because it was clear what the job was and what we needed to do was get on with it.

Now it's time that we bring together this very diffuse responsibility and coordinate it at one place. And as to the sort of representation, clearly one needs representation of every department within the Government that is playing a major role in space. One can tick off a half-a-dozen of these starting right after NASA with DOD and Commerce and Transportation and so forth.

I think also one wants to have people on there who are really experienced in the major aspects of the space program itself. Obviously, there is the increased knowledge about the universe, the space sciences program, which has always been extraordinarily well coordinated and planned. What we've lacked is a consistent dedication to continuing this with long-term funding and all the rest of it, that we know would actually be more gentle on the taxpayer in the long run than our existing start and stop sort of philosophy. We need people who understand the technology of space; we need people who understand the physiology and psychology of the medical aspects of man in space; and we certainly need the political scientists who understands what the various alternatives can do for us in terms of stature around the world, the educational psychologist in terms of what will be most inspirational. One can go on and on. But these are the sorts of things that I would see off the top of the head.

Mr. SMITH OF NEW HAMPSHIRE. I agree with you, and those were my thoughts as well. I guess the reason why I asked the question was because you said a small group—and I don't know how you define small—but I agree with you that a small group would be probably more desirable because you can usually accomplish more. But the amount of—When you look at the departments alone, as well as the people, the scientists and the others, where do you draw the line? I mean, what is going to be small? Are we going to be talking 30 people, 10 people, 100 people? I mean, you know, it's pretty difficult. You had to leave somebody out who might be able to add a great deal. Obviously, there are support staff. But I'm talking about those in the ring, in the loop.

Dr. CLARK. It's got to be far less than 30 if one is to be able to do any work at all. I had in mind a pyramidal advisory structure, pretty much along the way that the old NASA got advice from the science and applications community—the Space Science Board and these sorts of things. It's possible to get good advice, to know who the key players are and to call them in at the appropriate time in the deliberations, so that their advice can be an integral part of the mechanism without enlarging the membership, so as to having every one including the kitchen sink.

Mr. SMITH OF NEW HAMPSHIRE. One final question. This is a question I asked yesterday of another witness.

Would you like to see—Let me put it this way: would it be good if the National Space Council were to lay out a road map, say, up through the next—say 2050—the next half-a-century or so, to lay out a road map of where, not necessarily of where we would like to go, but perhaps where we ought to go in space, what we ought to be doing, how the international cooperation would dovetail in, how the private sector would fit in, where—how that—all of these things into the picture, irregardless of budgetary consideration for the moment. In other words, lay out—I don't—we used to use the term "dream sheet" in the service—a dream sheet, yes, but where we ought to go in the next 50 years or so, and then, after that is out there on the board, so that we can see what we ought to be doing, if we have to retreat from it, wouldn't it be better to retreat from what we ought to be doing than trying to build with blinders on, working within the constraints of a $14 billion NASA budget, little projects popping up like daffodils in the spring for this mission and that mission, and nobody is seeing the whole picture.

That's the way I see this. I said this the other day—and I don't mean to repeat myself, Mr. Chairman—but I know the Chairman has agonized over this and he's grappled with this for the four-and-a-half years that I've had the privilege to serve on the committee with him, and I think that we're all looking for this leadership to come out and give us that road map and then say "All right, this is what we ought to be doing, and if you can't do it, then here's what we ought to do next." But I don't see that. Maybe I'm wrong, but I don't see it. I'm hoping that this National Space Council can do that.

Dr. CLARK. Very well said, Mr. Smith. You're speaking of a vision. Anybody who says that we should not attempt to see our vision as far enough ahead doesn't have much vision.

One important thing. We should not be surprised if our vision changes in ten years, in five years, in one year, and in some cases in a week, as we learn more. But it's far better to set up the best road map that we can perceive from this distance and then change our course as we learn more along the way.

Mr. SMITH OF NEW HAMPSHIRE. But as a footnote to that—and that's a very good point—what we do here on the committee—we hear it with the ACTS program and we hear it with other things when there's always a proposal either to cut this or cut that—what we hear is not always that the program is worthwhile or it isn't worthwhile. What we hear is well, we've expended x-number of dollars, so many millions or billions or whatever it is, on this project. We've gone too far. We shouldn't stop.

Well, if we're looking at priorities, maybe there are times that we should stop if, in fact, it's going to cheat another project that may or may not be more important in the future. I just don't see us making those kinds of decisions. What we're forced with here on this committee is to make a decision on a particular item in the budget, without really seeing the road map. We're laymen—I am, anyway; I'll speak for myself. The Chairman's been up in space. I can't call him a layman.

But we're not really seeing that road map. You're not—Not you, but some of the people who come in and testify are not telling us that this thing, this project or that project doesn't fit or does fit into the thing. They're just saying we spent this money; therefore, we might as well complete it. That's not the way I would like to see the space program in this country run. I think we can support you if we know where—we can support the space program if we know where it's going, where it's been, where it's going, where it is now. And I just would hope that in your conversations with anyone who may be on that Space Council, or any one of your colleagues in the professions, to at least speaking as one Member, I certainly would like to see that kind of thought, that kind of dialogue, begin to take place.

Dr. CLARK. You're talking about the precise sort of oversight that I like to see this committee undertaking, and looking at the priorities and looking at these objectives, both long-term, intermediate and short-term.

And, by the way, you mentioned ACTS. I don't think we should ever be reluctant to stop a program whose objectives are no longer important. But I would certainly never put ACTS in that category. The committee has been, I think, very wise in continuing to fund a program which, through a rather unfortunate combination of circumstances, the administration has not seen fit to support—

Mr. SMITH OF NEW HAMPSHIRE. I was just going to say, it is not the scientific community that does this. It's the administration that always says it's not important.

Dr. CLARK. That's right. And the objectives are extremely important to our international competitive position. It's just too bad that it's been so long in coming.

Mr. SMITH OF NEW HAMPSHIRE. But there again, why is that one always singled out? I hate to use one example, but that one is always singled out. How many years, Mr. Chairman, has that been cut and we've put it back? I don't even remember.

Dr. CLARK. Four, I believe.

Mr. SMITH OF NEW HAMPSHIRE. In the last five years, the Chairman says. You know, there's really never any explanation given for it. We can't afford it, maybe—well, we can't afford a lot of things. It's just very frustrating and very difficult I think for us to be in the proper oversight role to deal with it that way. I know the Chairman has wrestled with it and has agonized over it as well, and the whole committee has.

I think you'd find tremendous support here in this committee, and hopefully in the full House, for a lot more—than you've gotten support for in the past—if, in fact, we could see that road map and know where everything fits in. And if it changes two years down the road, that's great. They will change. Things will change. We'll know that. Tell us that and then we can begin to oversee more properly.

Dr. CLARK. If there was ever a time in the space program that such a map can be put together competently, this is it.

Mr. SMITH OF NEW HAMPSHIRE. I agree.

Dr. CLARK. And the Space Council is the agency to do it. I just hope the administration will get on with it.

Mr. SMITH OF NEW HAMPSHIRE. Thank you. I agree with you. Thank you.

Dr. CLARK. Thank you, sir.

Mr. NELSON. Any further questions? Thank you, Dr. Clark. We appreciate it. May I ask the next panel to come up, please.

Dr. CLARK. Thank you, Mr. Nelson.

Mr. NELSON. Thank you.

We want to welcome Dr. Simon Serfaty, Executive Director of Johns Hopkins Foreign Policy Institute; Dr. Paul Blanchard, President of Space Research Management, Inc.; Dr. George Seielstad, Assistant Director for Green Bank Operations, National Radio Astronomy Observatory; and Mr. Thomas Rogers, President of The Sophron Foundation here in Washington. We welcome you. We would ask each of you to make a brief personal statement and then we'll get into some questions. We'll start just in the order that I introduced you. Dr. Serfaty.

STATEMENTS OF SIMON SERFATY, EXECUTIVE DIRECTOR, THE JOHNS HOPKINS FOREIGN POLICY INSTITUTE; GEORGE A. SEIELSTAD, ASSISTANT DIRECTOR, NATIONAL RADIO ASTRONOMY OBSERVATORY; PAUL ADAM BLANCHARD, PRESIDENT, SPACE RESEARCH AND MANAGEMENT, INC.; AND THOMAS F. ROGERS, PRESIDENT, THE SOPHRON FOUNDATION

Dr. SERFATY. Thank you, Mr. Chairman, and thank you for the invitation to attend and participate in this morning's discussion. It is, indeed, a pleasure. It is a privilege to be here today.

My role as Executive Director of the Johns Hopkins Foreign Policy Institute is essentially to introduce the program within the framework of which other members of this panel developed ideas and proposals for the new administration.

This Foreign Policy Institute program was launched early in 1988. The focus of the program had to do with the future of U.S.-Soviet relations. And we had, in a sense, two major objectives, distinct but complementary.

The first objective was to review, assess, define the landscape that has emerged of late between the two countries in the light of changed and changing circumstances within each one of them and between the two of them. To do so, we wanted to see whether it was possible to define the boundaries of a bipartisan consensus on the basis of which a new administration in Washington might pursue, reassess, slow down, accelerate some of the trends that have emerged over the past two years with regard to U.S.-Soviet relations.

The second objective of that program, and one that is of immediate relevance to the interest of the subcommittee, was to attempt to develop an agenda for the future that would help populate that landscape, to help identify those perennials that might endure the passing of the seasons between the two countries, as we have seen many such passing of the seasons take place in the past.

Accordingly, we launched a nationwide search for new ideas, new proposals, that might promote some measure of cooperation between the U.S. and the Soviet Union. We wanted to escape the traditional issues of arms control and conflict resolution in the Third World, and economic relations, and touch, indeed, upon the issues which we at the Foreign Policy Institute are not too familiar with and reach people whom we did not already know to a fundamental sense of traditional academic activities, as you know.

We received about 250 proposals, touching upon a variety of fields—space, education, art, culture, and so on and so forth. A few of my colleagues and I selected 20 of those proposals which in our view represented the most interesting, the most challenging, the most diversified menu of options that might be addressed by the new administration as it come into office in January of 1989. Those proposals were all released separately and together. They were, indeed, presented to members of the new administration a few weeks ago, and my three colleagues on this panel—and, indeed, among the happy few, so to speak—were selected as part of that nationwide core.

Now, I will not take any more time away from a discussion of substantive issues over which Dr. Seielstad, Dr. Blanchard and Mr. Rogers know much more than I do. I will therefore pass on the matter of this discussion.

Thank you.

[The prepared statement of Mr. Serfaty follows:]

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

STATEMENT BY:

DR. SIMON SERFATY
EXECUTIVE DIRECTOR
THE JOHNS HOPKINS FOREIGN POLICY INSTITUTE

FEBRUARY 9, 1989

SAIS

The Johns Hopkins Foreign Policy Institute
School of Advanced International Studies

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
HEARINGS, FEBRUARY 9, 1989

STATEMENT BY DR. SIMON SERFATY
EXECUTIVE DIRECTOR
JOHNS HOPKINS FOREIGN POLICY INSTITUTE

Since March 1985, Moscow's new leadership has issued increasingly radical calls, and taken increasingly significant steps, for economic and political reforms in the Soviet Union. These calls and corresponding actions are pointing to directions generally more compatible with long-standing Western interests, and more responsive to Western values than under any previous Soviet leadership. Both in declaratory policy as well as in fact they invite us to explore whatever opportunities may thereby exist for further improvements -- and even breakthroughs -- in U.S.-Soviet relations.

To be sure, the stability and continuity of changes now taking place in Soviet outlook and policies remain uncertain--pending the resolution of obstacles of history, geography, mass apathy, and opposition within the party. But the United States cannot simply wait for those uncertainties to be resolved: there are risks in any action, but no less so in failing to act.

That any such action should remain clearly based on the primary consideration of U.S. and Western interests is neither new nor, accordingly, truly significant. But that the Soviet Union would now show a keener appreciation of common and parallel interests, as well as a more realistic assessment of the world and its interdependent political and economic processes than in the past is both new and, therefore, significant.

In advancing proposals of our own, therefore, we should not be limited by rigid perceptions of what Moscow can accept; willingness to cooperate should be imaginatively probed so that Soviet flexibility can be examined fully. Indeed, a new Soviet flexibility has already been shown in the context of the December 1987 treaty on the elimination of intermediate nuclear forces (INF) -- whose negotiation, however, pointed to the risk of making tactically attractive proposals on the sole assumption that the Soviet government is certain to reject them. Now, with regard to ongoing talks on strategic forces, Soviet leaders appear prepared to go as far as the United States in the direction of arms constraints and reductions -- and it is for us and our allies to set the level and range of nuclear weaponry deemed necessary, and negotiate down to that level. Similarly, in conventional arms, the Soviet public commitment to accept asymmetrical reductions to eliminate superiorities on the two sides, and to restructure deployed military forces in Europe to reduce that capability for offensive action is especially significant, and cannot be ignored.

Yet, maintaining momentum in U.S.-Soviet relations should not be limited to the sole issues of arms control or even regional conflict resolution in the Third World (also the focus of much improvement during the latter part of the Reagan administration) and human rights in the Soviet Union (in which case much remains to be done notwithstanding the reality of some welcome changes in recent years). Preparing a sustainable consensus on improved relations between the two superpowers requires a sophisticated and mature national policy of discriminate engagement that encourages changes in, and interaction with, a modernizing and moderating Soviet Union while guarding the fundamental security interests of the United States and the West.

Beyond the most traditional East-West issues, we should therefore, together with our allies, encourage a continued expansion of exchanges and joint projects in a broad range of scientific, medical, artistic, cultural, and educational areas, both publicly and privately sponsored. Such projects -- related to proposals that may be nearly infinite in scope and diversity-- can be construed as the perennials that will endure the passing of seasons in U.S.-Soviet relations.

For there will be other winters. Even under the most favorable circumstances, however defined, managing the peace between the two superpowers will not escape the frustrated hopes and dangerous crises that stand as tollbooths to the future. Hopes placed on the future of reforms in the East remain at the mercy of unpredictable -- or, according to some, all too predictable -- detours or dead ends: changes in any one country in Eastern Europe that would cross Moscow's own tracing of the boundaries of permissible ideological differences; dislocations within the Soviet empire that would sweep away the search for reform and mark the return to oppression at home and adventures abroad; and dangerous crises in Third World countries that remain all the more possible as the renewed appeal of democracy raises expectations which, should they be ignored, might generate new instabilities that will sorely test the resilience of new relations between the two superpowers and their respective allies. As then-Vice President George Bush noted in October 1988, the wrong policy "could turn the most promising era in superpower relations into a replay of the Cold War."

In sum, every good season comes to an end, but those perennials planted on time can reliably endure the winter and ensure the return of the spring. It is with that consideration that, in January 1988, the Johns Hopkins Foreign Policy Institute (FPI) of the School of Advanced International Studies (SAIS), with the generous support of the W. Alton Jones Foundation, launched a program designed to assess the changing nature of U.S.-Soviet relations and devise an agenda for the future. With regard to topics, we wanted such an Agenda to cover the widest possible range of issues that might not only expand the menu of U.S.-Soviet interaction but might also, by the very nature of the rewards provided to both sides, be insulated from the vagaries of the overarching political relationship and perhaps, over time, help stabilize that relationship. With regard to participants, we wanted to escape narrow dependence on a handful of experts in the beltway area, and, instead, seek out and rely on a broader group of experts and professionals from around the country -- in the hope that, altogether, their proposals would combine initiatives that could be implemented quickly and at limited cost together with more ambitious initiatives that might test further the boundaries of the thinkable even if they might require more time and resources for their implementation.

Accordingly, we launched a nationwide search that relied on personalized solicitations to thousands of specialists in international relations as well as public announcements in numerous publications, newsletters, and bulletins with a global readership of nearly three-quarters of a million. The response to our call was quite gratifying. Within a few weeks, we received more than 225 proposals that were submitted by junior and senior academics, active and retired foreign service officers, doctors, lawyers, scientists, union leaders, businessmen, architects, peace activists, students and housekeepers from 40 states, the District of Columbia, and a few foreign countries. Twenty of these proposals were selected, and their authors invited to develop their ideas further, for presentation to panels of experts in Washington, in the fall, and publication and wide dissemination a few weeks later. Brief summaries of all 20 proposals appear as an appendix to this short introductory statement.

Mr. Chairman, three of the witnesses you have scheduled to appear in front of this subcommittee this morning are among the twenty authors whose ideas were identified as especially promising. We, at the FPI, are, of course, delighted that you found their proposals sufficiently attractive to invite them to appear before you.

Dr. Paul Adam Blanchard holds a Ph.D. in astronomy from Harvard University, and is a specialist in long-range studies of scientific and technical programs, particularly those related to the scientific and commercial uses of space. Dr. Blanchard founded Space Research and Management, Inc. in 1985, and currently serves as its president. He will discuss how and why the United States and the Soviet Union should each construct, and place into polar orbit, a research satellite or space platform equipped with remote-sensing instruments and intended to carry out similar or complementary observations of the Earth, concentrating particularly on global changes in the environment.

Dr. George A. Seielstad received a Ph.D. in physics from the California Institute of Technology. He currently serves as the Assistant Director for Greenbank Operations at the National Radio Astronomy Observatory, in Greenbank, West Virginia. Dr. Seielstad urges the United States to accept the Soviet invitation to participate in an international project -- called RADIOASTRON -- designed to launch a radio telescope into orbit around the Earth and link it electronically to radio telescopes on the ground.

Mr. Thomas F. Rogers is a physicist, an electronics-communications engineer, and a private investor. He currently serves as the president of his family's private operating foundation, The Sophron Foundation, and as chairman of the External Tanks Corporation. Mr. Rogers' proposal calls for the creation of a global, satellite, audio broadcasting system that can provide service on a common-carrier, common-user basis, which would give the United States and the Soviet Union, as well as other countries around the world, equitable access to high quality service at much lower unit cost.

APPENDIX

AN AGENDA FOR THE FUTURE

ECONOMIC RELATIONS

1. A (Partially) Convertible Ruble

Steven Rosefielde

> **Partial convertibility of the ruble is most likely to be achieved with Western cooperation. If extended, such cooperation would provide the United States (and the West) with significant trade benefits. And it would also provide leverage over Soviet conduct in other arenas.**

A strategy of cooptive integration of the Soviet Union into the world economic community can be pursued as a complement for deterrence. To be achieved, such integration requires a fundamental change in the Soviet economy: a mechanism that can make the ruble competitively convertible within the limits of the prevailing regime. Soviet interest in achieving ruble convertibility on their own -- to expand the scale of their commerce and enhance its efficiency -- is known. Yet, the success of this reform depends on Western cooperation, whose subordinate goal would be a concomitant improvement in Western material welfare brought about through increased East-West trade.

Convertibility would serve to advance American commercial interests. Under current institutional arrangements the Soviet government enjoys a monopoly of trade that enables it to discriminate against its trading partners in two ways: by setting the exchange rate above the competitive level, and through confidential bilaterally negotiated transactions designed to allow price discrimination. As matters now stand, most-favored-nation tariff exemptions would give the Soviets competitive access to the U.S. market without a meaningful quid pro quo. Ruble convertibility would eliminate this problem.

The simplest approach to ruble convertibility would be for the Soviets themselves to abolish legal prohibitions barring Soviet citizens and unauthorized state agents from exchanging rubles with foreigners, and parallel restrictions preventing foreigners from holding or spending rubles obtained from unapproved sources. This approach is eminently feasible but unrealistic. It would subvert the state's economic priorities by allowing disapproved parties to influence the level and composition of foreign trade.

However, this difficulty can be circumvented by restricting foreign market participation in varying degrees. For example, the State Price Committee could continue to set output and factor prices, but a few selected agents would be permitted to engage in international trade, allowing managers of approved enterprises to make their own import and export decisions. In this case though, the ruble would still play only a perfunctory role because international commerce would be conducted entirely with hard currency receipts -- the proceeds of unauthorized export sales.

Real competitive commercial convertibility begins when the state and/or selected state agents auction domestic hard currency assets to would-be state import agents in accordance with the forces of supply and demand. The easiest way to accomplish this would be to permit selected state agents to bid competitively for hard currencies held by exporters or the state banks, but without authorizing the direct sales of rubles to foreigners.

Rudimentary free convertibility could be achieved merely by allowing potential importers to exchange a portion of their ruble holdings for domestically held foreign-currency balances on a competitive, negotiated basis. Firms and other agents with relatively strong demand for hard currency would be prepared to outbid their rivals, with rubles being exchanged for foreign currencies at diverse prices until the sanctioned international auction market is cleared.

This process would broaden the import market, and stimulate exports and entrepreneurship, without infringing on the taboo against free currency exchange between domestic entities and foreigners. In addition, if multiple foreign entities (state and private banks) were allowed to participate in the internal Soviet hard-currency market, a convertible market for the ruble with flexible exchange rates would automatically develop in the West in the usual competitive fashion.

Partial convertibility would assuage Soviet fears that their domestic economy might become captive of the vagaries of the world market, and that the internal hard currency auction would be inefficient and counterproductive. With regard to external disturbances, most Soviet import and export activities are transacted at world market prices, and the introduction of this new foreign-trade mechanism would extend such practice. If augmented import demand adversely depreciated the ruble, the central authorities could either curtail their import programs or alter the incentive controls.

The implementation of this initiative should take place in stages. First, economic and national security specialists would evaluate whether such a strategy is viable and contains proper safeguards. Second, the bipartisan support of key congressional leaders would be sought. Third, after these requirements are met, official approaches would be made to Soviet authorities. Fourth, if they are amenable, a conference of Soviet and U.S. experts would be held to develop a concrete strategy for implementing the policy. And fifth, the recommendations of this conference would be reported to the responsible authorities of both countries for further deliberation and final action.

Bringing the Soviet Union into the world economic community through partial convertibility of the ruble would open the Soviet economy to Western influence, and provide commercial benefits at limited risks, since trade restrictions could still be renewed and expanded, credit curtailed, and U.S. participation in the ruble exchange market banned, thereby degrading its efficiency.

2. A Soviet Special Economic Zone

Charles E. Ziegler

> **The United States should encourage and facilitate the development of a special economic zone in the Soviet Far East.**

In September 1988, Mikhail Gorbachev confirmed his interest in the establishment of a special economic zone centered around the port city of Vladivostok in the Soviet Far East. Previously, this area had been singled out for growth targets higher than elsewhere in the country, for a range of industries that included consumer services and export capabilities. Now, the special economic zone evoked by Gorbachev contemplates a preferential treatment in custom duties and licensing, in foreign economic deals and related taxation, and in reduced fees paid for natural and labor resources.

The area seems well chosen for such an experiment. The Soviet Far East is rich in oil, natural gas, timber, coal and various nonfuel minerals. With the Baikal-Amur railway close to completion, and with the port capacity of the nearby city of Vostichnyi recently enhanced, the transportation infrastructure of the region has been improved, adding further to the geographical advantages of the region -- close as it is to the American West Coast, Japan, and the newly industrialized countries of the Pacific basin.

Encouraging and facilitating the establishment of the Soviet special economic zone would be a useful course for the United States to follow. To the extent that economic growth follows the light consumer good pattern projected in Soviet plans for the area, and as long as the United States and Asian countries follow guidelines established by the sixteen-nation Coordinating Committee that regulates East-West trade (COCOM), the projected special economic zone need not conflict with U.S. security interests in the Pacific.

Viewing the process sought by the Soviet leadership as non-threatening would help make U.S. equipment and management skills available to extract, process, and export the natural resources available in the Soviet Far East, and such a natural complementarity of economic interests would be conducive to new opportunities for investment through joint enterprises and for the sales of American products to the USSR.

In the near term, U.S. support for such a project would not require such steps as the guarantee of credits, the revocation of the Jackson-Vanik amendment that links trade with Soviet emigration policies, or the relaxation of COCOM's restrictions on the transfer of high technology, defense-applicable equipment to the USSR. Yet, U.S. firms that enter into long-term arrangements with the Soviets for the development of the region would need reassurances that future U.S. administrations would not impose unilateral economic sanctions.

Finally, U.S. participation in a successful Soviet special economic zone would help demonstrate the efficacy of relaxing controls over central planning, strengthen the proponents of market mechanisms and private enterprise, and give added impetus to more extensive Soviet integration into the world economy. These in turn would help achieve long-standing foreign policy objectives by contributing to the emergence of a Soviet Union that is increasingly governed by consumer preferences and more open to individual initiative.

3. A New Export Regime for Information Technologies

Judith A. Thornton

> **While maintaining export controls for some important high-end computer technologies that have direct military significance, the United States should end export restrictions on low-technology commodity computers.**

Computers and related information technologies are unique in their importance to a modern industrial economy. They are unique in their pervasiveness, in the dynamism of the underlying technologies, and in their cost consequences for other technologies. They are central to modern finance and distribution, and to the design and manufacture of products in modern industry. And they are also direct and significant inputs into modern military systems.

Although it has the capability for being self-sufficient for its priority military and strategic needs, the Soviet Union lags behind the West to an extraordinary extent in its ability to supply the civilian economy with computer services. In the past, the Soviet performance has been hampered by self-imposed difficulties in acquiring and assimilating technology, the paucity of opportunities for Western businesses in the Soviet market, and Western export controls.

These limits are now being eased. Some, but not all, of the Soviets' self-imposed obstacles are being eliminated. The high priority given to the electronic technologies in current Soviet plans offers Western businesses opportunities for increased sales of computer products (however constrained by hard-currency earnings and the extent of Western credits). And even after substantial efforts by the U.S. government to narrow the scope and speed the process of export controls, the quick pace of technological change in the industry and the rapid growth of international competition in information technologies continue to outrun the ability of U.S. policymakers to keep export controls consistent with changing realities.

Although export controls for some important high-end computer technologies that have direct military significance should be preserved, it is also essential that the United States devote greater attention to the consistency of multilateral enforcement efforts, particularly as it expands efforts to bring non-COCOM producers into a new export regime. Overall, present controls hamper U.S. industry more than they do the Soviets, and the United States is simply not well served by policies that restrict the export of products Moscow can buy elsewhere.

If hard currency is available, Soviet-Western trade for non-strategic computer products would expand into a wide range of areas in computer products, provision of services, and cooperation in developing software and applications could be expanded. Examples include: i) computers in education, educational software, U.S.-Russian language translation; ii) nuclear plant safety or other areas of industrial safety including the training of safety personnel and design of safety equipment; and iii) computerized data management for health and epidemiology.

The U.S. computer industry is an important asset to U.S. national security. It makes a direct contribution to defense and contributes to the efficiency of the American economy. There is danger that restricting technology transfer could hurt the development of domestic computing. The objective of export control is to delay and to raise the cost of the upgrading of Soviet military systems. However, delay is of little value without concurrent rapid progress on our side; the best way to stay ahead in a race is to run faster. The United States needs to end export control of low-technology commodity computers.

4. Rethinking Business with the USSR

Laurence W. Britt

> **A new and bold U.S. economic policy toward the USSR is required to exploit the real opportunities for trade and investment created by current Soviet plans for economic reform.**

Existing U.S. legislation such as the Export Control Act and the Jackson-Vanik Amendment to the Trade Act of 1974 imposes a nearly impossible burden on trade relations between the United States and the Soviet Union. Much of this legislation grew out of a compelling policy rationale in the past. But its relevance to current conditions has now become questionable.

Moreover, instruments other than U.S. legislation have curbed U.S.-Soviet trade as well. The most notable such instrument is the Coordinating Committee (COCOM) on strategic trade control. Thus, in a study published in early 1987, the National Academy of Sciences concluded that drastically reducing the COCOM list of restricted products would make little if any useful military technology available to the Soviet Union, but that these restrictions cost U.S. companies as much as $9 billion in annual sales.

An American program of trade expansion with the USSR would generally benefit the U.S. economy not only because of its impact on U.S. exports but also because the related improvement in U.S.-Soviet relations would eventually permit cuts in defense spending that would spur U.S. international economic competitiveness.

The scope and durability of such improvements would clearly depend on the scope and durability of Gorbachev's success in implementing his avowed reform policies. Yet, a reversal of current trends in the Soviet Union would still leave the United States no worse off than it is today. While U.S. firms might have wasted some time and resources, there would have been a brief upswing in U.S. exports with little significance from the standpoint of military technology.

The United States should, therefore, articulate and implement a radically new U.S. economic policy toward the Soviet bloc aimed at a substantial expansion of U.S.-Soviet trade. Under this new policy, the United States would work with its partners in COCOM to reduce substantially the West's list of embargoed goods and technologies, and more effectively control those remaining items that need to be restricted for military reasons.

The new President should also formulate policies designed to encourage American businesses to enter into joint ventures with Soviet entities and to encourage the Soviets to expand the program as well. The Department of Commerce can work with U.S. trade associations and business groups to form trade consortia that would enable small- and medium-sized businesses to sell on the Soviet market. To enable a significant increase in trade between the United States and the Soviet Union, ruble convertibility is a must. The United States should take an active role in facilitating Soviet efforts to achieve this objective.

Large reserves in Soviet consumer savings, due to long-standing shortages of consumer goods, and untapped Soviet potential for foreign credits provide real opportunities for trade and investments. A new and bold U.S. economic policy toward the Soviet Union is required to exploit these opportunities in the light of current Soviet plans for economic reform.

SCIENCE AND MEDICINE

5. Combined Remote-Sensing Observations of the Earth from Space

Paul Adam Blanchard

> **The United States and the Soviet Union should each construct, and place into polar orbit, a research satellite or space platform equipped with remote-sensing instruments and intended to carry out similar or complementary observations of the Earth, concentrating particularly on global changes in the environment.**

Such observations are urgently needed. The environment for life on Earth is changing. The atmosphere, oceans, and land surfaces of the planet are undergoing significant alterations. Rising atmospheric concentrations of carbon dioxide resulting from fossil-fuel burning are creating a global warming trend. Industrially produced chlorofluorocarbons are depleting the Earth's protective ozone layer. And tropical deforestation is altering the global biogeochemical cycles of key trace elements essential to life.

The study of such worldwide environmental changes requires systematic scientific observations from space. Only satellite observations can provide the rapid, global, and synoptic view of the environment required for an understanding of the total Earth system and the role of human activities within it.

In collaboration with other Western scientific groups, the United States has embarked upon a vigorous program of satellite Earth remote sensing intended to provide this understanding. Space missions targeted for study of specific Earth-system processes, such as the ocean-atmospheric interaction and variations in the stratospheric ozone layer, will be launched in the early 1990s. In the mid-1990s, a comprehensive Earth Observing System will be established in polar orbit to inaugurate systematic, long-duration observations of the global environment; four space platforms, contributed by the United States, Europe, and Japan, will incorporate suites of advanced instruments for a wide variety of measurements to meet requirements for both research investigations and operational weather data.

Although the Soviets maintain an active program of satellite Earth remote sensing -- which in many respects parallels U.S. efforts and demonstrates substantial technological capabilities -- they have not cooperated, thus far, with the United States or its allies in joint studies of the Earth from space.

However, recent developments suggest that the Soviet Union is now ready to participate in international remote-sensing programs. These developments include: increasing Western access to Soviet facilities and personnel; heightened Soviet interest in international cooperation in space, particularly with the United States; and recent Soviet commitments to international Earth-study programs.

A Soviet space platform as part of the planned Earth Observing System could therefore be sought as a counterpart to one of the two platforms to be contributed by the United States. Such a contribution could take either of two forms.

First, instruments significantly different from those scheduled for the U.S. platform could be included on the Soviet platform, thereby permitting the effective use of each country's strengths. For example, the Soviets have gained extensive radar experience from the numerous radar-equipped satellites they have launched over the years and from interplanetary missions. Second, the United States could suggest that the Soviet platform be equipped with instruments that are functional duplicates of those used on the U.S. platform, making it possible to revisit important sites more frequently and to create backup systems in the event of instrument failure aboard either nation's spacecraft.

Sought with the approval of all other contributing countries, Soviet participation would substantially augment the scientific capabilities of the Earth Observing System. Such joint remote-sensing efforts would enable the West to exploit demonstrated Soviet strengths in seceral relevant technologies, such as radar. Soviet participation would also provide access to Soviet territory -- a vast and ecologically crucial protion of the Earth's surface. And with each superpower retaining control of the instruments on their respective satellites, the West could easily guard militarily significant technology.

6. A Radio Telescope Larger Than Earth

George Seielstad

> **To accept the Soviet invitation to participate in an international project -- called RADIOASTRON -- designed to launch a radio telescope into orbit around the Earth and link it electronically to radio telescopes on the ground.**

During the last three decades, our understanding of the universe has advanced almost explosively. The advance was not the result of incremental evolutionary improvements to existing fields of scientific investigation; rather it resulted from such revolutionary breakthroughs as the opening of the entire electromagnetic spectrum to astronomical investigation and the beginning of space exploration.

These two parallel developments intersect in the 1990s in a project to construct a radio telescope so large -- larger, in fact, than the planet itself -- that it will reveal angular detail finer than can any other telescope operating in any wavelength regime. Such details are likely to enable astronomers to probe for the first time the immediate environs of black holes, nature's most exotic and puzzling specimens.

The first portion of the electromagnetic spectrum outside the visible to yield to technology's thrust was the radio. For some decades, interest focused on the most violent and transient phenomenon, namely, the quasars discovered by radio astronomers. These objects shattered prevailing standards of distance, age, energy content, and density. Their radiating volumes are so small, though, that the ultimate source of their prodigious energy has remained hidden to any telescope's vision -- until radio astronomers began to connect independent antennas into a single, ultra-precise telescope.

This astonishing ability to couple distinct structures into a unit through a process called interferometry has enabled the synthesis of a telescope as large as the earth, a so-called Global Array. Now, the revolutionary ability to conduct activities in space makes it possible to connect antennas well beyond earth's dimensions to antennas on the ground to give the resolution necessary to penetrate to the core of quasars.

While several proposals for putting radio antennas in space exist, only one is, at this time, funded and under development. Yet, U.S. contributions to this first international Ground-Space Telescope -- an international project called RADIOASTRON originated by the Soviet Union -- have been difficult to arrange.

A firm commitment to active U.S. participation is now needed. The required contributions, representing only a fraction of the mission's total costs, would include: first, the transfer of special recording terminals to sites in the Soviet Union; second, the fabrication of a sensitive amplifier for 1.3 centimeter wavelength to be mounted on the space antenna; third, the construction in the United States of a large ground antenna linked full-time to antennas in space; and fourth, the addition of a two-way, ground-satellite communications station without which a shortage of available ground-space communications might soon emerge.

The first two of these contributions are needed immediately since components for the RADIOASTRON spacecraft are due by the end of 1991. Decisions pertaining to the third and fourth contributions should be made shortly thereafter to permit adequate time for major construction projects.

In addition, these contributions should be made within the grander vision that Space-Ground Telescopes will evolve into arrays linking several antennas -- perhaps as many as six -- in carefully chosen space orbits with a superarray of ground antennas. The U.S. should therefore also consider the eventual contributions of two or three orbiting antennas that would be about three times larger in diameter than the original RADIOASTRON antenna, and an International Space VLBI (Very Long-Based Interferometry) Institute to coordinate all activities.

To boycott RADIOASTRON would be to forfeit U.S. scientific participation in a field that Americans have driven to its present state of excellence. U.S. radio astronomers have introduced many of the technical developments that made this next stage possible. They possess some technologies that are superior to those of other nations. Their scientific appetites demand access to the data the space antenna will provide. In sum, U.S. participation to this project would strengthen it considerably without causing technology transfers that might arouse national security concerns.

7. Joint Development of an Inherently Safe Nuclear Reactor

Jack N. Barkenbus

> Joint design and construction of a new generation of nuclear reactors safe enough to be accepted by the populations of the United States and the Soviet Union.

A renewed examination of nuclear power is underway due to the possible climate-warming effects associated with other (fossil-fuel based) energy sources. At the center of this reexamination are so-called inherently safe reactors; that is, reactors designed to eliminate the possibility of the most frightening of nuclear accidents -- the core melt, or melt-down -- through the incorporation of passive safety systems based on chemical and physical laws of nature.

In the past few years, nuclear engineers have made impressive progress in developing plausible designs for an inherently safe reactor, and several variants have now emerged. However, commercial vendors (especially in the United States) fear that even a successful prototype -- which would cost hundreds of millions of dollars to construct and test -- would not significantly transform public apprehensions, thereby leaving the market for nuclear power wholly uncertain.

Cost-sharing for prototype construction and testing is therefore a necessity. Collaboration would also give reactor development a visibility or prominence that could not be achieved by working alone. Since U.S.-Soviet nuclear fission cooperation dates back to 1973, this initiative would simply be an expansion in collaboration rather than a novel undertaking.

A joint effort in this area need not be limited to the United States and the Soviet Union. International cooperative efforts in nuclear fusion research provide a useful model for organizing a truly international collaborative effort on inherently safe reactors. In April 1988, the United States, the Soviet Union, Japan, and the European Community agreed to proceed with an International Thermonuclear Experimental Reactor project estimated at $150 to $200 million. The same countries, plus other nuclear states such as China and India, could also contribute to an international inherently safe reactor program.

Before agreeing to proceed with such a project, scientists and engineers would first have to come to an agreement on the kind of reactor to be built (whether cooled by water, gas or liquid metal) and the specific safety standards they would seek. An inherently safe reactor project would also have to deal with a range of dispute resolution and technology transfer questions, as well as the loss of decisionmaking autonomy that each participating country would suffer. But similar issues have been dealt with successfully by governments involved in collaborative nuclear fusion research.

Inherent safety does not mean absolute safety. Nor does it necessarily translate into economic, cost-effective power. But with so few long-term energy options available, turning away from nuclear power simply because a panacea for its drawbacks does not yet exist would be mistaken. U.S.-Soviet and broader international cooperation on designing and constructing inherently safe reactors would add significantly to the range of energy choices for the benefit of future generations.

8. Cooperation in Surgical Oncology

J. Ralph Broadwater, M.D.; Michael J. Edwards, M.D.; Merrick I. Ross, M.D.; and Charles M. Balch, M.D.

> **A joint effort to disseminate practical knowledge of cancer therapy, beginning with an exchange of surgical oncologists, and focusing on the exchange of clinical information, the design and integration of clinical protocols, and the exchange of current oncological research.**

U.S.-Soviet medical cooperation dates back to 1956, and Soviet and American researchers have conferred on cancer-related topics since 1960. Yet, the effectiveness and increasingly sophisticated equipment of the Soviet cancer care program are not well known in the United States. Delivery of such care in the USSR is based on the dispensary principle, which combines attempts to eliminate the kinds of working and social conditions that tend to cause cancer; systematic observation of selected population groups; all forms of therapy; and rehabilitation.

In addition, Soviet doctors have had vast experience with an unusually large cancer-patient population, as well as with relatively stable population groups, a factor which allows for large-scale epidemiological studies. In short, the Soviet cancer program provides a sturdy pillar for a collaborative anticancer drive with the United States.

Surgical oncologists are a logical choice to spearhead such a drive. Their discipline requires a detailed understanding of multimodality therapy (which emphasizes a combination of treatments), and their practice allows them to manage patients with all stages of the disease. In addition, surgical oncologists must be familiar with epidemiology, statistics, clinical trial design, tumor biology, and immunology. Moreover, the integrated approach to cancer care they have developed has resulted in several important advances in patient care.

The proposal for an exchange program involving surgical oncologists would focus on encouraging the exchange of clinical information, the design and integration of clinical protocols, and the exchange of current oncological research. The program would unfold progressively in four phases, with the implementation of each phase dependent upon successful completion of the previous one.

Phase I would involve the exchange of senior surgical oncologists and aim principally at identifying specific areas of common interest. Senior oncologists from each country would visit the other for a three-week period in order to identify institutions willing to formalize working relationships with each other; outline similarities and differences in the current management of various major types of cancer; formulate suggestions for information exchange and protocol designs; examine similarities and differences in cancer care techniques; and identify epidemiologial questions for clinical research.

This exchange could begin six months following the adoption of the program. Limited funding would be required, possibly from the National Cancer Institute.

Phase II would utilize the sister-institution mechanism to improve the exchange of information and education resources between the two countries. Faculty members from participating institutions would meet to discuss specific tumors, outline potential clinical investigations, and begin protocol design. These meetings would also be used to present clinical and basic research. Publication of the proceedings would improve dissemination of the latest research results at limited cost. In addition, Soviet surgical oncologists could present their newest findings at the annual meeting of the U.S. Society of Surgical Oncology.

Phase II could begin approximately one year after implementation of the program. Funding for this Phase could be provided by participating sister institutions or through existing funding agencies.

Phase III would involve the exchange of physicians, and could start two years after launching the program. Junior surgical faculty would spend three months at their sister institution and participate in teaching, seminars, administration of protocols, and surgical demonstrations. Advances in surgical technology identified in the previous phases would be exchanged as well. Funding for Phase III -- chiefly for travel and expenses -- would be sought from the National Cancer Institute.

Successful completion of the first three phases would allow the program to expand into other disciplines of oncology -- radiation therapy, medical oncology, and basic cancer research. In Phase IV, physicians and scientists from these fields would be recruited and their participation centered around the previously established sister institutions. Again, funding would be sought from the National Cancer Institute, but specific projects would compete for funding through the standard grant mechanism. This phase could be implemented roughly three to four years after the beginning of Phase I.

DOMESTIC POLICY

9. Demonstration Centers for Educational Reform

Stephen T. Kerr

To initiate educational exchanges that focus on common problems of schooling and seek new perspectives on the organization of schools, different approaches to teaching, and an improved understanding of education as a social institution.

Education in the United States and the Soviet Union faces a surprising number of parallel problems: how to integrate different ethnic and linguistic groups into the larger society, how to use the new information technologies more effectively, how to attract and retain more and better teachers, and how to reorganize schools' administrative structures so as to enhance teachers' professional autonomy. Some of these problems could be addressed in common through a new series of educational exchanges based on the creation of two joint demonstration centers in each country.

These Centers would be designed to demonstrate new approaches to teaching, learning, professional development, and educational organization. They would be similar to experimental schools associated with colleges of education. Each Center would organize itself differently and undertake different projects, but all Centers would cover the full range of primary and secondary grade levels.

The size of each Center would be moderate: 360 students at the elementary level, 180 in junior high school, and 240 in high school. Students would represent a variety of urban, suburban and rural areas, as well as ethnic backgrounds. Each Center would employ teachers, administrators, and educational researchers from both countries. Joint teaching of classes would be encouraged.

Governing Councils with representation from both sides and from all educational roles would have authority over curricula, instructional strategies and materials, teaching assignments, school organization and operation, and professional development for teachers. They would also determine the type and scope of joint research and development projects to be pursued. Whenever differences within the Councils could not be bridged, final decision would rest with regional educational authorities for the Soviet-based Centers, and school district officials for the Centers based in the United States.

Funding would come from several sources. In the United States a portion--probably equivalent to funding for a comparable set of regular schools -- would come from the sponsoring school districts, with additional support sought from professional organizations, teachers unions, and, perhaps, foundations and corporations. Some federal money may be needed as seed money.

Each Center's professional staff would consist of about thirty-five Soviet teachers in the United States, and a like number of American teachers in the USSR, for one academic year: fifteen elementary teachers, and ten each at the junior and senior high school levels. A group of six educational administrators and three specialists would also be exchanged for each Center, where they would be joined by a comparable number of personnel from the host country.

Both in the United States and in the Soviet Union, a support network would be developed to assure that qualified teachers are identified and briefed, that research issues are appropriately framed and addressed, and that results are widely disseminated. In the United States, these networks could be modeled on or affiliated with the Coalition of Essential Schools, the National Network for Educational Renewal, the main teachers unions, and such other organizations as Phi Delta Kappa. In the Soviet Union, the Academy of Pedagogical Sciences, the teachers union, and the new Creative Union of Teachers could serve in this capacity.

Joint research and development programs dealing with a broad range of topics would be conducted in each Center. Some programs would proceed on parallel tracks in both countries; others would be carried out in one location only. In all cases, the focus would be on integrating theory and practice, on the applicability of results to real teaching situations, and on the collaborative investigation of problems.

The results of the Centers' work would be disseminated through local and regional workshops and conferences, presentations at professional meetings, and appropriate publications. Instructional materials based on the Centers' activities would be developed and published, and profits from the sale of these materials used for the operation of the Centers.

The educational reform project will be valuable for giving educators in the United States and the USSR experience in working jointly on a topic of mutual concern; it will also provide an opportunity to gain specific new ideas on upgrading schools. The project could be declared a success if those involved developed new perspectives on altering the organizations of their schools, arriving jointly at new approaches to teaching, and changing the nature of education as a social institution.

10. An American College in Moscow

Karen A. Weisblatt

An American College in Moscow, preceded by a smaller-scale American Center for International Relations and Business Management, would represent the newest of a long line of prestigious institutions abroad.

Before its opening by the turn of the century, a four-year, liberal arts American College in Moscow would be preceded by a smaller-scale American Center for

International Relations and Business Management. Such a Center would be loosely modeled after both the Bologna (Italy) Center of the School of Advanced International Studies of the Johns Hopkins University and the Johns Hopkins University-Nanjing University Center for Chinese and American Studies in the People's Republic of China.

The American Center in Moscow would offer a one-year interdisciplinary program of studies in International Economics and Politics, Business Management, and History to approximately 100 qualified undergraduate and graduate students from a variety of fields, universities, and countries. English would be the primary language of instruction, and a diploma (as well as relevant academic credit hours) would be awarded upon satisfactory completion of the program.

The Center faculty would be recruited from universities in the United States, the Soviet Union and other countries. Members of the business and diplomatic communities in Moscow woud also be called upon to enrich the program with guest lectures and presentations. The Center would be administered by resident coordinators appointed by the host institutions.

After a period of five years the Center would be reviewed and a decision made with regard to the transition to a full College whose establishment would preserve the identity of the original Center as a graduate institution.

The College proper would be fully accredited and registered in the United States and around the world, and it would grant the degrees of bachelor of Arts or Bachelor of Science. A full curriculum of courses would offer majors in such subjects as Arts History, Russian Literature, Soviet Area Studies, English, American Area Studies, European Studies, Communications, Religion, Philosophy, History, Government, International Affairs, Comparative Literature, Computer Science, and International Economics. Upperclassmen with appropriate language skills would be permitted to take some courses in neighboring Soviet institutions.

The international faculty would enjoy traditional American academic freedoms, including responsibility for appointments and academic standards. Admission to the coeducational college would be based on several factors, including high school performance, standardized test scores, personal references, and a personal interview. Every effort would be made to create a student body where all nationalities, races, and religions are represented. Soviet students would be chosen in the same way as their American counterparts, but, like all other non-English speaking students, they would be required to pass the test of English as a foreign language.

Funding for the American College in Moscow would come from corporate, foundation, and individual donors in both countries. Admittedly, the project would be costly to develop and to run. The college would be cosponsored by a Soviet University, one of the Soviet institutes of international relations or American studies, or a state ministry. The College itself would be administered by a bipartisan American board of directors composed or prominent citizens knowledgeable about international relations and a similar body should oversee the creation of the college.

Although the College would be a self-contained unit, outreach programs organized to serve the needs of the local and foreign communities would provide useful cultural and intellectual links with the city and the country.

11. Cooperation to Protect the Environment and Conserve Resources

David McClave

> **To pool the scientific and technological expertise of the United States and the Soviet Union to stave off a series of threatening environmental crises.**

In the United States, new warnings about the depletion of the Earth's ozone layer and the accelerating disappearance of tropical rain forests, the scorching summer of 1988, and water pollution bad enough to close major bathing beaches in the northeastern part of the country have served as dramatic reminders of growing environmental problems. Similarly, in the Soviet Union, the 1986 nuclear accident at Chernobyl, the near-destruction of the Aral Sea, and the befouling of Lake Baykal have belied the standard ideological myth that pollution is a byproduct of capitalism only and caused astonishingly uninhibited discussions and debates among Soviet officials and scientists.

In contrast to most governmental agencies in the two countries, the agendas of both the Environmental Protection Agency and the new State Committee for the Protection of Nature largely coincide. Citizen-capitalists and citizen-socialists alike prefer clean water and air over polluted water and air; given the choice they would elect to preserve the sable, the sturgeon, the timber wolf or the bald eagle rather than preside over their extinction.

In line with a general agreement on cooperation in environmental protection, and building upon the foundations provided by several joint ventures already under way (for example, working groups on climate and ozone protection, and joint research expeditions in the Bering Sea), specific cooperative endeavors should be initiated between the two countries' agencies responsible for environment protection and conservation of resources.

Some of these endeavors could be administered by jointly staffed environmental protection offices in the capitals of the two countries. Related activities would include taking the ecological "vital signs" of each country at various bases -- monitoring, for example, ambient air quality in industrial centers. Problems associated with water use and pollution in the arid regions of both countries are serious enough, especially in the Soviet case, to warrant special attention and emergency corrective measures.

The U.S.-Canadian Waterton Glacier International Peace Park could be used as a fifty-year-old precedent and model for the creation of a U.S.-Soviet Nature Preserve, a potential World Natural Heritage Site spanning the Bering Strait and encompassing parts of Alaska and the Chukchi Peninsula. This project would be an ecological workshop emphasizing wilderness and wildlife preservation.

Additional projects could also be launched to further cooperation in other spheres. Thus, monitoring airborne pollutants and ozone layer damage involves space research and activities, an area in which both countries excel. Resolving the problem of safe disposal of nuclear waste would draw upon decades of experience each country has had in the peaceful uses of the atom.

A gradual shift toward policies and programs based on deep respect for and appreciation of both national and global ecosystems could be brought about through such collaborative Soviet-American efforts in environmental protection and conservation of resources.

12. A Bilateral Endowment for the Arts and Humanities

John Logan Burrow and Patricia O'Leary

> To promote a qualitatively new form of exchange program through which creative artists and humanities specialists from one country can live, travel, and work for extended periods of time in the other country.

Cultural exchanges between the United States and the Soviet Union remain far too modest, especially given the cultural achievements and heritage of both societies. Moreover, current exchanges concentrate almost exclusively on displays and performances, and limit the possible impact of cross-cultural fertilization by restricting the scope of artistic and creative interaction. A new Bilateral Endowment for the Arts and Humanities would be designed to broaden and deepen the present tentative cultural dialogue.

First, the Endowment would pursue those aspects of the 1988 U.S.-Soviet cultural agreement that still require further negotiation -- including the details of activities and exhibits already approved, as well as arrangements for more permanent programs such as cultural information centers.

Second, the Endowment would promote exchanges not covered by currently agreed quotas for scholars and scientists, and it would also facilitate exchange programs in the arts and humanities between private U.S. organizations and their closest Soviet counterparts (universities for example). In addition, the Endowment would enable individuals not affiliated with established groups to apply for the funding needed to participate in exchange programs.

Third, the Endowment would help fulfill the government's pledge that cultural exchange programs will not be sustained with taxpayer dollars. Over a period of time, the Endowment would be expected to become self-sufficient -- even though it would still rely for its services and locations on other institutions. For instance, royalties from the proceeds of exchanges and sales of art could be used by the Endowment as a source of funding.

The Endowment would be designed to give artists and humanities specialists a chance to immerse themselves in representative aspects of a foreign culture for much longer periods than most exchange programs currently permit. The variety of exchanges would be limited only by the imagination.

For example, publicizing design competitions in both countries through the Endowment would make it possible for architects and city planners to contribute their own distinctive national perspectives to a variety of specific projects: Soviet planners and architects could teach their American counterparts about concepts that reflect ethnic diversity; in turn, the Soviets could benefit from exposure to U.S. concepts that emphasize cultural, environmental, and economic requirements.

In music, the Endowment could help Soviet composers explore opportunities in the American commercial music industry, while American musicians could compose scores for Soviet films. Where existing exchange programs for philosophers and theologians stress specific research projects of short duration, the Endowment would give these scholars the possibility to study and teach in the other society for more than a semester or two. And, finally, the Endowment would provide new exchange opportunities in non-traditional fields as well -- in the area of design, for instance, where the marketing skills of American designers and the Soviet predilection for durability could be seen as complimentary.

At the outset, a broad agreement on major philosophical and operational questions would be sought among U.S. officials responsible for cultural exchanges, representatives of foundations and endowments, and distinguished members of the American arts community before any plan could be presented to the Soviets. As part of this agreement, an individual or an institution would be appointed to enlist the interest of possible sponsors; to seek the support of elected officials; and to examine the most effective institutional form the Endowment would ultimately take.

The Endowment would be governed by a Board representing both countries and appointed by their respective governments. Board members would serve staggered terms and meet at least twice a year. Day-to-day operations would be handled by a modest staff, with annual costs ranging from $100,000 upward, depending on the scope and range of services offered. At one end of the cost spectrum, the Endowment would be a paper organization with mainly communicative functions -- to recruit talent and borrow facilities for its activities from other institutions. At the other end, offices could be set up in both countries, with a staff to provide participants with such varied services as travel assistance, updates on changed legal conditions, and helpful official contacts.

Periodic staff reports would help monitor the work of the Endowment. In each of its national settings, the staff would publicize the Endowment's activities, solicit grant proposals, and acquaint visiting artists with projects held in the host country. Finally, the Endowment would also launch and pursue a dialogue on the impact of the U.S.-Soviet relationship on the human condition, about which it would report periodically and publicly.

DEFENSE AND ARMS CONTROL

13. Converting Nuclear Missiles for Peaceful Use

William C. Potter and Ann M. Florini

> **To permit, in the context of a bilateral arms control agreement, the conversion of U.S. and Soviet decommissioned ballistic missiles into space launchers for peaceful purposes.**

A prospective agreement on deep cuts in strategic weapons will confront the United States and the Soviet Union with the task of eliminating large numbers of ballistic missiles. Rather than dismantling and destroying them, the two countries should negotiate a START accord that permits each of them to convert their decommissioned ballistic missiles into space launchers for peaceful purposes.

The technical feasibility of using retired missiles as boosters for spacecraft has already been demonstrated by both the United States and the Soviet Union. Past conversions, however, have never been done in the context of a bilateral arms control agreement. Whereas most INF missiles would have lacked the thrust required to be cost-effective boosters, the larger missiles currently under review in the START negotiations could place a variety of payloads into orbit.

The cost of using converted missiles varies greatly depending upon the missiles, launch facilities, and payloads under consideration. However, prior conversion experience and present commercial interest suggest that economic savings for certain kinds of space launch activities may be substantial. Indeed, U.S. private firms have already expressed interest in using some of the ballistic missiles likely to be covered in a START accord for commercial space launch purposes, including the MX and the Poseidon C-3. On the Soviet side, the SS-18 and SS-19 would appear to be attractive candidates for conversion given their relatively large size and payload capacity.

Converted missiles would contribute to the growing U.S.-Soviet cooperation in space. Useful missions that could take advantage of the launchers include the study of space weather, a probe to the sun, and study of global environmental problems such as the depletion of stratospheric ozone and the "greenhouse effect."

In addition, converted missiles could also provide launch services for developing countries, where the potential of telecommunications and remote-sensing satellites for use in agriculture, industry, education, health and social services in the Third World has long been recognized. Most developing states, however, simply cannot afford to build, launch, and operate satellites, and do not have the ground facilities to take advantage of the satellite data already available. An international effort led by the United States and the Soviet Union could exploit decommissioned ballistic missiles to assist developing countries that need to acquire satellite services. In so doing, a missile conversion plan would demonstrate the tangible benefits that arms control can bring to Third World nations. This demonstration could be especially important in gaining support for renewal of the Non-Proliferation Treaty at the 1995 Review Conference.

A missile conversion program would require verification safeguards whose intrusiveness would depend on the number and kinds of systems to be modified, the pace of conversion and the time period for launch of converted missiles, the extent of international cooperation envisaged in the space launch program, and the specifics of the strategic arms control accord which affords the opportunity for conversion. Although verification measures would entail a combination of national technical means and on-site inspection neither the verification requirements nor the costs of verifying conversion are apt to be substantially more than would be necessary under a START treaty without a conversion clause.

The united States and the Soviet Union are now in a unique position to reduce the risk of nuclear war by eliminating large numbers of ballistic missiles and simultaneaously to spur international cooperation in space. If they seize the opportunity, they could demonstrate a space-age version of beating "swords into ploughshares."

14. Strategic Information Exchanges as Confidence-Building Measures

Paul Chrzanowski, William Dunlop, Peter Moulthrop, and George Staehle

To organize regularly scheduled information exchanges between the United States and the Soviet Union on strategic nuclear weapon systems in the areas of safety, future capability, and current effectiveness.

With the Soviet Union moving away from past practices of releasing no information with possible military significance, prospects for the exchange of some categories of information on strategic weapon systems have improved, and regularly scheduled strategic information exchanges should now be sought in the areas of safety, future deployment, and weapon yield.

Safety-related exchanges could cover methods to prevent unauthorized use, inadvertent launch, accidental detonation, or accidental dispersal of radioactive particles. Most of this information would be equally applicable to tactical nuclear weapons. While much of the related data is currently unclassified in the United States, past experience has shown a Soviet interest in receiving official confirmation of what is otherwise available in the public domain.

These exchanges would include both descriptions and some demonstrations and would focus on three subjects: preventing accidents -- by the use of safety and security devices and by the use of insensitive high explosive; minimizing the consequences of accidents--through emphasis on technical approaches to improved safety; and attending to the consequences of various accident scenarios -- which would entail an examination by Soviet and American experts of the potential for plutonium contamination and the criteria for cleanup.

Exchanges on deployment plans for strategic weapons would take place according to a regular schedule -- perhaps annually. Initial notification about new systems would be made from eight to ten years in advance of deployment. Notification would not imply a commitment to deploy by a specific date, or even to deploy at all. But an agreement to exchange deployment plans would be explicitly understood as a solemn commitment not to deploy any system that has not been included in the information exchange.

Information to be shared would include data on numbers to be deployed, yields, and basing schemes. This information would be particularly important if a strategic arms reduction agreement leaves both countries with many fewer strategic weapons because the consequences of treaty breakout may be more dangerous with smaller arsenals.

Deployment-related information exchanges could be a logical extension of the data exchanges on current forces that are included in the INF treaty and are part of the START talks. They would also be in some ways a natural extension of the recent and unprecedented exchange visits of senior U.S. and Soviet defense officials. Strategic information exchanges on deployment plans are seen mainly as a confidence-building measure, but could also contribute to strategic stability by helping to prevent the kind of misunderstanding that developed over the Soviet deployment of SS-19 intercontinental balistic missiles after the 1972 SALT I agreement.

Finally, the two countries could exchange information on the yields of weapons currently deployed on ICBMs, submarine-launched ballistic missiles, strategic cruise missiles, and strategic bombers. The exchanges would also include measures to corraborate the accuracy of the yield values. Yield information on U.S. systems has appeared in the open literature, but Soviet secrecy prevents the United States from having high confidence in its estimates of Soviet yields.

To strengthen its reliability, the exchange of yield values could be accompanied by an exchange of the dates of any nuclear tests on which the expected yield value (as known at the time of deployment) is based, and by an exchange of the yield of that test; differences between the two would have to be explained. More intrusive checks of the yield values could be considered as well -- perhaps by exploiting the opportunities for on-site inspection that may be included in a START treaty.

Strategic information exchanges would help make nuclear weapons safer, reduce uncertainties about future deployments, and cultivate the kind of openness required for further improvements in U.S.-Soviet relations.

15. Military Liaisons between NATO and the Warsaw Pact

John A. Fahey and Philip S. Gillette

To exchange military liaison missions between the North Atlantic Treaty Organization and the Warsaw Pact that would provide for continuous and direct on-site liaison and communications at the highest operational military level.

In 1987 and 1988, the scope of the bilateral U.S.-Soviet military dialogue expanded dramatically, with an unprecedented series of high-level visits and agreements for further exchanges and the establishment of a joint working group to explore the issue of dangerous military activity.

An exchange of military liaison missions between NATO and the Warsaw Pact would help advance and expand such a dialogue. Located at or near the military headquarters of the Warsaw Pact (Moscow) and NATO (Mons, Belgium) these missions would aim at providing continuous and direct on-site liaison and communication at the highest operational military level in Europe.

Currently, the most visible lines of communications between the two alliances are the official communiques they both issue routinely. Since 1973, NATO and the Warsaw Pact have also been engaged in the Mutual and Balanced Force Reduction Talks (MBFR) in Vienna, Austria. The Helsinki process includes a review conference every three years, as well as two specialized forums on security issues: the Conference on Confidence and Security Building Measures and Disarmamement in Europe (CEE) and the Conventional Stability Talks (CST), expected to begin in 1989. Both the MFBR and Helsinki Forums are directed by political and diplomatic personnel, not military officers.

The existing links between the two alliances in Europe are sparse, especially at the purely military level. In contrast, on-site military liaison has been functioning in Germany since 1947, when the Huebner-Malinin Agreement established Military Liaison Missions accredited to the Soviet and American commanders-in-chief of their respective zones of occupation. (The British and French have maintained military liaison missions under parallel agreements.) The apparent success of these missions suggests that bloc-to-bloc military liaison missions would also be worthwhile.

Military Liaison Missions between NATO and the Warsaw Pact would be designed to promote common interests and mutual understanding, to provide direct on-site liaison and communications at the highest operational military level in Europe, and to serve as on-site instruments for a myriad of liaison functions. They would be strictly military missions -- with no authority over political or diplomatic missions, and their staffs would contain no political representatives.

The staff members of each mission -- limited to twenty-five officers and enlisted personnel -- would receive diplomatic immunity, and each mission would have full rights of extra-territoriality. Staff members would enjoy identical travel rights, and requests to visit military facilities would be honored on a reciprocal basis, under the supervision of the host command.

Finally, these missions would be especially well-suited to handle incidents arising between the two alliances that now fall outside existing military channels of communication. In particular, they could help defuse incidents involving the armed forces of countries not participating in Huebner Malinin-type missions (for instance, West Germany), or handle problems occuring outside the geographic area covered by these agreements (Czechoslovakia, for example).

The establishment of bloc-to-bloc military missions would respond to an apparent interest of Soviet and Warsaw Pact leaders in promoting greater contacts between the two alliances. They would also help devise an Alliance-wide liaison arrangement with the Warsaw Pact that would be preferable to a proliferation of bilateral military dialogues and/or missions between members of the two alliances, which might otherwise be the result of Soviet initiatives.

In sum, the organization of alliance-to-alliance military missions would apply forty years of experience with bilateral liaison missions in East and West Germany to cover the entire range of East-West military issues in Europe. This plan would significantly expand East-West cooperation without requiring fundamental changes in the U.S.-Soviet relationship. But it would provide a foundation for such changes if and when the necessary international political conditions emerge.

16. A $100 Billion Understanding

Barry M. Blechman, with Ethan Gutmann

> **To devise with the Soviets a menu of arms control agreements designed to achieve sizeable cuts – as much as $100 billion – in defense expenditures without altering the respective roles in the world of the United States and the Soviet Union.**

Arms control agreements must not be negotiated primarily for economic reasons. Far more basic considerations of national security and international political relationships hinge on these agreements, and should always dominate decisionmaking. Still, could the prospect of significant economic benefits help shape and realize a significant restructuring of the U.S.-Soviet relationship and resulting progress in arms negotiations? Could the United States bring to the table a tacit long-term objective of negotiating arrangements necessary to cut defense expenditures by one third -- "a $100 billion understanding" with the Soviet Union whose related savings would be comparable-- without altering the American role in the world?

Reaching such a goal is obviously a tall order. There is nothing certain about the cost implications or arms control agreements. Quite apart from the uncertainties of cost data, deciding what to include among the fiscal implications of an agreement and what to exclude is a matter of taste, judgment, and perspective. What can be most generally said is that budgetary savings from arms agreements concluded to date have been modest, to say the least; and some previous agreements, in fact, may have led to even greater defense expenditures.

Let us assume, nevertheless, a negotiating agenda that would include four kinds of agreements: a treaty to make "deep cuts" in central strategic forces, like the one now being negotiated in the Strategic Arms Reduction Talks (START) together with a reaffirmation of the Anti-Ballistic Missile (ABM) treaty's prohibition on deployments of missile defenses; an agreement to reduce by half U.S. and Soviet ground and tactical air forces in Europe; an agreement to reduce by 20 percent the size of the two countries' navies; and an agreement to reduce the two great powers' ground and air forces in Northeast Asia.

Admittedly, such an arms control agenda would be extraordinarily ambitious. The agreements on strategic weapons might be close at hand, but the likelihood of a European agreement on that scale within the next few years is remote. And the naval and Asian agreements have never been seriously contemplated by either government and are very unlikely to become part of the official agenda.

Even so, the total potential savings that would result from these agreements would range between an estimated $66 billion and $30 billion, depending on the assumptions used, and fall short of the $100 billion sought initially.

Yet, these results are not insignificant. Continuing progress in U.S.-Soviet negotiations make possible the avoidance of increased defense expenditures that would or might have taken place in the absence of an agreement and can never be known with certainty. A 20 to 10 percent cut in the defense budget would not solve the U.S. fiscal problem, but it would make a sizable dent. And, obviously enough, it is better to cut forces as a matter of choice, in exchange for corresponding Soviet reductions, than to do so reflexively, in response to the automatic cut provision of deficit reduction legislation.

FOREIGN POLICY

17. A Soviet-American Peace Corps

Alan Robock

A joint Soviet-American Peace Corps would increase U.S.-Soviet understanding and serve as a model for a cooperative approach toward the resolution of some fundamental problems of development in Third World countries.

The U.S. Peace Corps currently has 6,500 volunteers serving in 65 countries overseas. Similar volunteer organizations from 15 other developed countries have an additional 7,000 volunteers serving in the Third World. U.S. Peace Corps volunteers cooperate with their counterparts from other countries, but all the coordination takes place in the field as the Peace Corps has no bilateral agreements with other volunteer organizations.

Although the Soviet Union has no Peace Corps-type organization, its growing interest in cooperative ventures in Third World countries is reflected in the activities of the Soviet Peace Fund and the newly created International Foundation for the Survival and Development of Humanity.

In fact, the U.S. Peace Corps is already committed to one small development project involving the Soviets (in Costa Rica) and is considering another joint medical effort in Kenya. The "Partners-in-Development" project -- sponsored by Seattle-based Ploughshares and the Soviet Peace Fund -- is planning joint teams of ten American and ten Soviet volunteers to work on projects in the United States first, and in the Soviet Union next, before moving on to a model project in a developing nation on problems related to child health.

Designed to parallel the goals of the U.S. Peace Corps, a Soviet-American Peace Corps could be started most easily by building on a project already administered by the U.S. Peace Corps. Section 301 of the Peace Corps Act allows its director to spend up to 2 percent of the annual Peace Corps budget on such joint efforts, with no need for separate authority or appropriations from Congress. Candidates for limited demonstration projects with the Soviet Union as a first step toward a joint Peace Corps would include El Salvador and Vietnam.

The American-Soviet Peace Corps would work best if the U.S. Peace Corps and a parallel Soviet organization -- yet to be launched -- each formed different halves of a single joint Peace Corps. The new organization would be headed by one American and one Soviet co-director. Just as in the U.S. Peace Corps, volunteers would work together on two-year assignments in developing countries. Some American administrators would work in the joint Peace Corps office in Moscow, and some Soviet administrators would be assigned to Washington. Peace Corps training would take place in the host countries, as is the current practice, with American and Soviet volunteers studying local languages and culture. All joint projects would be started at the invitation of the host government and would operate under the direct supervision of a host-country national.

Legislation would be required to authorize and fund the joint organization. Funding would be shared equally between the two countries and could be expected to entail minimal additional expenditures on the side of the United States. The practice of giving volunteers a subsistence allowance to permit them to live at the same levels as their host country counterparts would continue, and Soviet and American volunteers would receive equal pay and free medical care, as well as a readjustment allowance or other benefits upon their return to their home countries.

The program could be inaugurated formally in 1992, a landmark year celebrating the 500th anniversary of Columbus' voyage to America and the 75th anniversary of the Bolshevik Revolution. By that time, the Soviet-American Peace Corps could be operating at full strength, with 10,000 American and 10,000 Soviet volunteers engaged in joint projects around the world. In subsequent years, it could be expanded to volunteers from other countries as the idea of national and planetary service becomes a norm.

18. U.S.-Soviet Cooperation on Terrorism

John Marks

> Cooperation against terrorism should be sought in addition to, and not instead of, existing counterterrorism efforts by either superpower. **Once implemented, such cooperation would provide an additional layer of protection against terrorism.**

Cooperation between the United States and the Soviet Union against terrorism would promote the interests of both countries in three principal ways. First, joint action might well deter or prevent specific acts of terrorism. Second, it would help transform the global climate in which terrorists operate by signaling that despite their differences the two countries stand united in their opposition to such acts. And third, it would represent an important confidence-building measure demonstrating how the two global powers can work together even in extremely sensitive areas.

Obstacles to such cooperation must not be overlooked. The two superpowers often support organizations that the other charges with committing terrorist acts. Neither country is likely to abandon these groups in the immediate future; nor are most of the groups likely to change their tactics any time soon. Accordingly, the superpowers are most likely to initiate cooperation not to counter specific groups but to prevent specific acts and the use of specific types of weapons.

Acts so abhorrent that they can never be justified might include: killing children, the aged, and the infirm; keeping such individuals hostage; hijacking or bombing airplanes; physical torture or kidnapping; attacking schools, hospitals, places of worship, and other humanitarian and religious sites; and attacking diplomats and international civil servants. Washington and Moscow should agree to treat such acts as crimes -- never as political acts -- whenever they occur, and no matter who carries them out.

Opposition to these acts should be demonstrated in many ways. The two countries should condemn the perpetrators consistently and publicly. They should work together to strengthen existing international agreements that protect civil aviation, require prosecution and/or extradition of terrorists, and forbid hostage-taking. They should organize a bilateral working group of legal experts whose task would be to examine and expand these agreements.

Potentially the most valuable -- but also the most sensitive -- area of anti-terrorism efforts would be the sharing of information. Yet counterterrorism services in both countries are extremely reluctant to make available such information. To overcome this reluctance every effort should be made to allay fears of damaging intelligence and technology leaks and to ensure that exchanges are mutually advantageous.

The process of sharing intelligence in a regulated, limited way could begin with meetings of high-level U.S. and Soviet counter-terrorism specialists and lead to the formation of a counterterrorism channel between the two countries -- used, for example, when either country had information about a particularly alarming act of terrorism. In addition, exchanges of information should begin with items deemed relatively non-threatening. These might include joint academic studies, exchanges on embassy defense measures, airport security, methods of handling terrorist incidents, development of joint data bases, or weapons detection with an emphasis on such emerging problems as the use of plastic handguns.

Finally, a joint U.S.-Soviet drive against terrorism should also focus on the terrorists' use of especially dangerous weapons technologies. The use of chemical, biological, and nuclear terrorism merits special attention. Unofficial U.S. and Soviet groups could provide both a testing ground and a sounding board for discussing these issues. Once the channels of communication and cooperation are established, action could follow.

The fact of U.S.-Soviet cooperation against terrorism would probably have as much impact as the specifics of the cooperation. The dangers of damaging intelligence leaks are well within the capacity of each country to minimize. And the advantages of cooperation in this area are sufficiently compelling to seek them actively.

19. Promoting Public Diplomacy through Direct Satellite Broadcasting

Thomas F. Rogers

To create a global, satellite, audio broadcasting system that can provide service on a common-carrier, common-user basis, thereby giving the United States, the Soviet Union and other countries around the world equitable access to high quality service at much lower unit costs.

Short-wave broadcasting has been the medium of choice for the transmission of news across borders. Yet, short-wave technology is now increasingly inadequate to each country's needs: broadcasting schedules are unreliable, signal quality is often poor, the world's airwaves face overcrowding, and listeners find it difficult to keep tuned to the broadcasters' changing frequencies. These shortcomings can be overcome by using powerful and sophisticated ultra high frequency (UHF) transmitters placed in geostationary orbit.

Recent or imminent satellite communications advances -- especially by America's government-industry Advanced Communications Technology Satellite (ACTS) program-- have become such that space-based audio broadcasting transmitters could begin to replace all surface-based audio shortwave transmitters well before the end of the century. They could enable governments to dispense with costly and politically vulnerable overseas repeater transmitters, and beam their programs more selectively and at a much lower unit cost. Best of all, their signals could be received by radios as inexpensive and easy to operate as today's over-the-air local broadcast sets.

The key element of the space-based segments of the Direct Broadcast from Satellite-Audio (DBS-A) would be an array of subtransmitters, each coupled to one or more large antennas capable of radiating a large number of narrow, shaped beams toward Earth. The selection of beams, the allocation of program channels, and the setting of radio frequency power levels for each beam would be accomplished by means of dynamic electronic switching in the satellites, all under the control of the space segment's surface feeder station. The switching would respond to the broadcaster's changing needs for serving specific audiences (and therefore surface areas), and compensate for the vagaries of radio wave propagation related to the surface areas being served by each of the beams. Each space segment would be designed to operate as part of a regional system, and would be connected with others via optical or millimeter wavelength in-space links.

Acquisition costs of the space segments of the global DBS-A system are estimated at about $500 million, plus $200 million for space segment research and development. The audio channel lease prices would be apportioned to each of the broadcasting governments to reflect that fraction of the services' capability used by each of them. (The shortwave broadcasting governments now spend about $1 billion a year to retain, operate, and maintain their shortwave broadcasting plant.)

The DBS-A service would involve mixing publicly (or perhaps privately) owned space components with privately owned surface segments; sorting out responsibilities for technology development, manufacture, distribution, and operations between the public and private sectors; and meshing these domestic economic interests with the commercial and industrial interests of other countries. To deal with these complex issues, the President and the Congress should establish a central federal DBS-A office to oversee and coordinate all DBS-A activities.

An initial U.S.-Soviet pre-DBS-A agreement would permit each country to use existing commercial satellite communications relay channels and their own television broadcasting networks to provide audio programs that would supplement their present shortwave audio broadcasting services quickly and at limited cost.

For instance, a daily thirty-minute Voice of America program could be relayed to Moscow in "standard" fashion using an Intelset microwave channel or a similar channel operated by Intersputnik and a single, modest microwave receiver. From Moscow, the VOA audio channel could be circulated to all of the local over-the-air television stations in the Soviet Union for local broadcast at the hour when Soviet television broadcasting comes to a close. A similar arrangement for broadcasting Radio Moscow programs in the United States could be devised using the Public Broadcasting System's local over-the-air television sound channel, or National Public Radio's sound channels. or both. The relatively modest cost of such programming could be met by federal appropriations, and/or (preferably) foundation or corporate contributions.

An early step toward creating a worldwide DBS-A service could be made by the VOA using in-orbit commercial communications satellites to broadcast audio programs to relatively sophisticated microwave receivers located near existing local over-the-air AM and FM broadcasting stations and cable systems. These signals could be made available to local broadcasters and cable system operators by the international broadcasters for real-time or delayed transmission to local audiences. The USIA's growing foreign Worldnet television reception assets could help begin a demonstration program.

The creation of an international DBS-A service would be a particularly effective use of space for the benefit of all mankind. And, especially for the two superpowers, the cooperative use of space to improve international public communications should rank at least as high as undertaking a cooperative program to travel to Mars.

20. An Advisory Council on American-Soviet Relations

Jack Perry

> **To create a national Advisory Council on American-Soviet Relations to help achieve continuity in the formulation and implementation of U.S. policy toward the Soviet Union.**

The lack of a continuing central ground for policy formulation in the United States makes it difficult to fashion a steady, workable, coherent, and sellable American policy toward the Soviet Union. The creation of a national Advisory Council on American-Soviet Relations would aim at improving such a situation.

Appointment to the Advisory Council would be made by the President with the consent of the Senate. Members would include academics, businessmen with experience in East-West commerce, military leaders, arms control specialists, scientists, retired diplomats, and representatives of cultural groups, church bodies, peace organizations, and Soviet emigres.

Like other governmental advisory bodies, the American-Soviet Council would be headquartered in Washington, D.C., although it could meet in various locations. A small professional staff would prepare its meetings and issue its reports. Just as the U.S. Advisory Commission on Public Diplomacy oversees the operations of the U.S. Information Agency, the Council would oversee, in a very general way, the activities of government agencies responsible for the various parts of America's Soviet policy. Although the panel would not serve as a watchdog over clandestine operations affecting the USSR, it would consider how the overall functioning of the intelligence community fits into the planning of U.S. Soviet policy.

To make a difference, the Council would not be limited to oversight. It would also have a broad mandate to assess the state of U.S.-Soviet relations at any given time, and to make judgments about the policies flowing from such assessment. Its private reports to the President and other senior officials would lay out alternatives and provide new Presidents in particular with at least some basis for grounding policy in Soviet realities as well as domestic political considerations. In public reports, the Council could explain the state of U.S.-Soviet relations in a nonpartisan way that would downplay mood swings and emphasize enduring interests irrespective of momentary tides in politics or sentiment.

To be effective, the Council would have to overcome the skepticism traditionally shown toward such advisory bodies -- whether from Congress or the bureaucracy. Yet, as a nonpartisan and nongovernmental entity comprising a limited number of distinguished Americans of recognized stature, the Council's assessments would enjoy considerable credibility.

In addition, the Council could help merge the disparate elements of U.S. policy toward the Soviet Union into a genuine strategy incorporating diplomacy, economics, and military power. One of the Council's most valuable contributions would be to examine the country's strategic needs, and place defense planning and the defense budget squarely within that context.

Finally, the Advisory Council would give the executive branch support for addressing an unruly Congress. By setting forth facts, and outlining what is in the national interest, the Council would give civil servants a standard that could not be easily ignored, and, on this most vital issue, help pull together the vast U.S. government.

Creation of the Council would not be a panacea. But it would help move the United States in a direction that applies the strength and understanding of the American people to the prime foreign policy challenge facing the nation.

AN AGENDA FOR THE FUTURE

Charles M. Balch, M.D., is professor and head, division of surgery; chairman of the department of general surgery; and professor of immunology, at the M.D. Anderson Cancer Center in Houston, Texas.

Jack N. Barkenbus is deputy director of the Energy, Environment and Resources Center, University of Tennessee at Knoxville, and of the Institute for Energy Analysis, Oak Ridge Associated University, Oak Ridge, Tennessee.

Paul Adam Blanchard is president of Space Research & Management, Inc.

Barry M. Blechman is fellow at the Johns Hopkins Foreign Policy Institute.

Laurence W. Britt is business manager for Xerox Technigraphic Products, Rochester, New York.

J. Ralph Broadwater, M.D., is assistant professor of surgery at the University of Arkansas for Medical Sciences, Little Rock, Arkansas.

John Logan Burrow is a practicing attorney who also serves as the popularly elected Coroner of Washington County, Arkansas.

Paul Chrzanowski is group leader, conducting systems-analysis activities in support of strategic-force modernization programs, at Lawrence Livermore National Laboratory, Livermore, California.

William H. Dunlop is division leader for nuclear-weapons design at Lawrence Livermore National Laboratory.

Michael J. Edwards, M.D., is assistant professor of surgery at the University of Louisville, Kentucky.

John A. Fahey is associate professor emeritus of foreign languages and literature at Old Dominion University, Norfolk, Virginia.

Ann M. Florini is studies coordinator at the Center for International and Strategic Affairs at the University of California, Los Angeles.

Philip S. Gillette is associate professor of political science and the director of the graduate program in international studies at Old Dominion University, Norfolk, Virginia.

Ethan Gutmann is research assistant for the Conventional Balance Project at The Brookings Institution.

Stephen T. Kerr is professor of education and chairman of the department of curriculum and instruction in the College of Education at the University of Washington, Seattle.

John Marks is executive director of Serach for Common Ground.

David McClave is senior research analyst (language specialist) in Soviet and East European Affairs at the Federal Research Division of the Library of Congress.

Peter H. Moulthrop works on arms-control issues at Lawrence Livermore National Laboratory.

Patricia O'Leary is professor of architecture at the University of Arkansas.

Jack Perry is director of the Dean Rusk Program in International Studies and professor of political science at Davidson College, Davidson, North Carolina.

William C. Potter is executive director of the Center for International and Strategic Affairs at the University of California, Los Angeles.

Alan Robock is associate professor of meteorology at the University of Maryland, College Park.

Thomas F. Rogers is president of The Sophron Foundation, McLean, Virginia.

Steven Rosefielde is professor of economics at the University of North Carolina, Chapel Hill.

Merrick I. Ross, M.D., is junior faculty associate, department of surgery, M.D. Anderson Cancer Center.

George Seielstad is assistant director for Greenbank operations at the National Radio Astronomy Observatory, Greenbank, West Virginia.

George G. Staelhe has been a project leader for several warhead development programs and is also involved in studies on arms control at Lawrence Livermore National Laboratory.

Judith A. Thornton is professor of economics and director of the Institute for Economic Research at the University of Washington, Seattle.

Karen A. Weisblatt is administrator in the office of student activities at the American University in Paris, France.

Charles E. Ziegler is associate professor of Political Science at the Univeristy of Louisville.

Mr. **Nelson**. Dr. Seielstad.

Dr. **Seielstad**. Thank you, Mr. Chairman.

I would like to describe a specific project that is underway, and as you'll see, is self-evidently international—in fact, I could almost describe it as non-national. It is a next step in, a next logical step, in a technical and scientific evolution that has been in an area of science that's been extremely productive and extraordinarily interesting both to the public and to the broad spectrum of the scientific community. But it's not an ordinary evolutionary step. It's a gigantic one, because it would extrapolate some of our techniques into the space dimension and at a precision that astronomy has never enjoyed before.

Along the way I'll touch on two issues that I'd like to bring up, one, the issue of technological transfer and how it has affected us in this specific project, and also the idea of what cooperation on joint international ventures means at the working level.

I prepared a few visuals to help me out a little bit. And this first one shows the idea, when you're talking about making an antenna larger than the Earth, if you glance at that—and I think I handed these packets around in case that's invisible from where you're sitting.

Radio astronomers have evolved a very successful trick to make a very large aperture by using small pieces. Antennas as small as 80 feet in diameter, but spread all across the globe, can give you the effect of a telescope as large as the entire planet. We have done so, and I would emphasize that in this case scientists from all nations on the ground portion, all were winners by cooperating. There is no nation whose geographical boundaries are large enough that the entire array can be centered within those boundaries. Therefore, cooperations have come among working scientists that have put in place a global array.

And the next step I think is obvious, that you put in an antenna in orbit and extend to make a telescope that's now in this case larger than the Earth and is approaching the dimensions of the solar system.

The next visual is just an attempt to show you what's being the scientific thrust for this. I would say that the "Holy Grail" now for the astrophysics community is the black hole. We look at objects like this. This is a confusing picture, but what you see as you go lower down the diagram is a blow-up of the central portion of each figure above it. And so when we start at the top, you're looking at something that spans millions of light years in dimension, but it's the center part that we think powers all the radio energy spreading across those light years. And so we blow up that center portion until down at the bottom you're looking at only about 100 light years, which to an astronomer is kind of a trivial dimension. Nevertheless, you're left with the impression that there's some central engine providing the energy that shoots out along a jet and feeds these enormous lobes throughout the intergalactic space.

That engine is believed to be a black hole. If you've been watching the New York Times best seller list, Stephen Hawkings has had a book on there now for many weeks, and has probably sold a million copies. He's kind of the theoretical father behind the black hole concept. So it not only electrifies the scientific community, but the public as well. We're proposing working on a telescope that would, if anything, give us our first glimpse that such things exist, not just in the fertile minds of the Stephen Hawkings of the world, but in the physical reality. So the scientific justification is solid.

The next visual shows some what we call VLBI's. Stands for Very Long Baseline Interferometry. I don't want to scare you. It's just a technique for linking antennas electronically, whether they be on the globe or in space. The feasibility of the technique has been tested, so we know the technology is present to do it. And you see here three different missions. The long oribital one is a Soviet proposal called RADIOASTRON, which has a launch date now of 1993. This is an ongoing project. They're building the hardware. They plan to launch the small antenna, 10 meters in diameter, into Earth orbit.

The Japanese proposal is VSOP, their acronym, but it also has a launch date, approximate launch date now, in 1995. There's one up here that's identified with ESA called QUASAT. That's been a joint NASA-ESA effort that hasn't made it to the top priority yet, so there is no alive project to do this. But I would suspect, by the late 1990's, this idea won't die and that the U.S. and Europe will probably get involved.

The important point is these missions don't compete. You're filling in—If you remember the first cartoon, you had this big aperature that was pretending to fill in. The more individual pieces you have, the faster that filling-in process goes. So that, in a sense, these projects are all coordinated and all complement each other.

Down in the lower left corner there are some frequencies listed, that you're going to have—the spacecraft and the antennas on the ground are just raw antennas. It's like the aerial on your car. You also need the gadget inside with all the electronics that boost the signal.

To show you the multinational nature of these projects, the lowest frequency there, .3 Gigahertz, those receivers will be provided for the spacecraft by India, the next one up by Australia, the 5 Gigahertz by West Germany and the Netherlands. The 22 Gigahertz receivers, my own organization, called the National Radio Astronomy Observatory, was invited to contribute those receivers to be put on the Soviet spacecraft. This is where—this invitation was issued in 1987. We have the technology to do it and the willingness and desire to be part of this project. It did involve technology transfer. We submitted an application for an export license that went to the Office of Munitions Control at the State Department, and that application was denied. I brought along with me a model—this is not a model. This is actually one of the devices that we would like to have exchanged with the Soviet Union for incorporation into the spacecraft.

We understand and worry as much as all citizens about national security implications, but believe strongly in this case that this does not constitute a dangerous weapon and could easily have been transferred and would have made a significant contribution.

The other point to make is, because we were not able to provide this, it did not stop the project. They have now relied—The technology for doing this involves a Japanese transistor available to all the countries of the world. The design of the amplifier has been published in the open literature by electronics engineers from various countries. So a laboratory in Finland is providing this device. So the only effect has been to exclude U.S. participation in the mission, but not to slow the mission in any way.

Finally, in the last viewgraph, I won't go into great detail. There's a lot of components that could be discussed here. All I will say is one other comment enters at the bottom of this viewgraph. If you will notice, the secret data is pouring in at an enormous rate and has to be stored on sort of high-density tape recorders, which come from Honeywell but are slightly modified. This is another item we would like to exchange with the Soviets and have not received permission to do so.

The problem is the Canadians will fill the gap with us, instead of us. The Canadian design we know. We now have to bring tapes together to a central organization called this Correlation Facility at the very bottom. This country is investing a lot of money in building one of those. The problem it's going to encounter is, tapes will come in—if I may use an analogy—in a VHS format from our telescopes on the group, and from the Soviet contribution, because of this Canadian design, it will be like having a beta format and you won't be able to bring the system together.

So something that has worked beautifully as far as putting telescopes across the globe by letting the scientists get together and make the necessary cooperative steps they have to has hit a barrier and it's creating an extremely awkward situation whose sole effect so far has been to prevent U.S. scientists and engineers from being part of the project.

One other issue is about cooperation. I've mentioned technology transfer. I'll now mention what it means to work on a joint cooperative venture.

We know the scientists in the Soviet Union, in Poland, in Australia, Canada, India and these other countries that are involved and feel capable of working with them. We would like to. We feel we have something to contribute that would make the mission better for all of us. There are no losers in this. There are only winners in this game.

When the President and Mr. Gorbachev signed a joint space cooperative agreement, we thought gee, at the bottom we'd like to cooperate; at the very top of these two nations there are signals that we should cooperate. And you'd think that eased the way and made life easier.

Instead, it's become very awkward. Joint working groups get set up, administrators get involved, paperwork gets shuffled around, meetings only occur occasionally, and if I can draw an analogy, it would be as if you had brought me to testify here but I had to give my testimony to someone in Mexico City who met once every six months, and he would deliver the message to you, and you would ask a question and six months later it would be delivered to me. That's the kind of problem we've encountered.

So despite the fact that this project has been ongoing and involves about 15 or 18 nations around the world, East Bloc and West Bloc, is scientifically justified and is one to which we could contribute, so far we've been able to contribute nothing. I think this is too bad. I think this is an electrifying thing that should be done.

And now, as far as cost effectiveness goes, the things at the bottom of this drawing are on the ground, and by comparison with putting the telescope in orbit, which is a 300- or 400 million dollar job, the rest of it's peanuts and a lot of it's in place. And the stuff on the ground competes for every one of these space missions, which we think will just—we're opening up a new field and we think there will be several. So the cost per mission keeps getting cut down by the number of missions, whereas that 3- or 400 million comes every time. That's the end of my presentation.

[The prepared statement of Dr. Seielstad, with attached charts, follows:]

A Radio Telescope Larger than Earth

Testimony to House of Representatives
Space Science and Applications Subcommittee
February 9, 1989

George A. Seielstad
Assistant Director
National Radio Astronomy Observatory
Green Bank, West Virginia

The Soviet Union has initiated a multinational astronomy project of enormous potential scientific importance and has invited the United States, along with several other nations, to participate. The project, called RADIOASTRON, aims to launch a radio telescope into orbit about the Earth and to link it electronically to radio telescopes on the ground. With orbital deployment making possible the construction of a system larger than the Earth itself, the combined Space-Ground Telescope would be able to distinguish detail in heavenly objects far better than any other telescope operating at any wavelength. Consequently, it could shed new light on problems at the forefront of physics and astronomy.

The scientific merits of RADIOASTRON are so widely appreciated that astronomers in Japan, Europe, and the United States have, both independently and in various combinations, proposed similar radio telescope projects. Test observations have already verified the technical feasibility of this technique and further confirmed its scientific potential. Scientists around the world agree that orbital deployment would boost existing radio astronomy capabilities by orders of magnitude. Rarely are such leaps within reach; rarely is there such unanimity on the desirability of taking them.

NASA so far—two years after U.S. participation in RADIOASTRON was requested—has been noncommittal toward participation in this venture, although the Agency appears at last to be moving quickly toward a decision. American indecisiveness, however, has been costly. One consequence has been that other nations have agreed to contribute some of the hardware components originally sought from the U.S., thereby forcing American scientists into a lesser role. A second negative consequence has been to slow progress in a global endeavor whose international political and scientific benefits greatly outweigh any conceivable risks or costs. It is still not too late for the RADIOASTRON project to benefit from U.S. contributions, but the clock is ticking. U.S. participation, with several other nations, would signal a willingness to participate in international projects without being the dominant partner. This might help cancel some of the negative consequences of past failures to complete joint missions once agreed to.

For these reasons the new administration should promptly accept the Soviet invitation and should specifically identify RADIOASTRON as a project to be carried out under the aegis of the June 1988 U.S.-USSR Space Cooperation Summit Agreement. Once a commitment is made, then U.S. participation can only be useful if two other U.S. government actions follow immediately: (1) minimization (or elimination) of bureaucratic involvement in the cooperation, and (2) sensible resolution of the issue of technology transfer. One might assume that the U.S.-USSR Treaty on Space Cooperation, signed in 1987 by both President Reagan and General Secretary Gorbachev, would signal easier scientist-to-scientist cooperation. But such has not been the case. Instead NASA and its Soviet counterpart have instituted joint working groups for various disciplines. RADIOASTRON, for example, falls under a Joint Working Group in Astronomy and Astrophysics. Since these groups meet only periodically and include in their membership several people who are not actually working on the project, all actions are unnecessarily delayed. As to technology transfer, if none is permitted, agreements to cooperate degenerate into paper commitments only. Specific hardware items needing export licenses will be identified in the following. One should note that past denials of export licenses for hardware the USSR requested and the U.S. wished to supply have not stopped RADIOASTRON. Instead other western nations have agreed to provide the components we were best suited to provide. The only consequence, then, has been to exclude U.S. scientists from continuing in the technical evolution of a field they brought to its forefront stature.

The Impact of Radio Astronomy

Radio astronomy provides a graphic example of how science and technology can extend human senses. Until the 1930s and 1940s, humans could observe and explore the universe only through one small portion of the electromagnetic spectrum--the visible. Opening up the radio portion of the spectrum to astronomical investigation enabled people to detect radiation that is invisible to human eyes, although differing from visible light only in its wavelength. Radio astronomers also learned quickly how to produce images sharper than any the eye can see.

The results generated a paradigm shift in astronomy. Just as Galileo's telescope not only brought fuzzy images into focus but revealed surprising new classes of structures (sunspots, Jupiter's moons, Saturn's rings, and the like), radio astronomy has unveiled a sky filled with strange phenomena whose existence centuries of study with optical telescopes had not even hinted at. The image of a serene, eternal void was superseded by that of a veritable maelstrom of volatile--even violent--and astonishingly ephemeral objects. So revolutionary were some of radio astronomy's discoveries that pressure to exploit other portions of the spectrum proved irresistible. By now the subdisciplines of X- and gamma-ray astronomy, as well as infrared and ultraviolet, have all been opened for investigation.

Among the phenomena revealed by radio astronomy, the most amazing take place at the cores of certain active galaxies. This class of objects, whose extreme manifestations are called quasars, shattered prevailing standards of distance, age, energy content, and density. The detected radio signals from quasars can be strong, yet considerable evidence suggests that they are billions of light-years distant, at the very edge of the known universe. Any object appearing that strong from so far away must be radiating an almost inconceivable amount of energy. A typical quasar, for example, might be several thousand times more energetic than our entire Milky Way galaxy. Moreover, the power output of quasars sometimes changes by large factors in mere weeks or months. Such changes only are possible if the volume within which the power is generated is relatively tiny--that is, not much greater than the size of the solar system. Small, remote objects like quasars present minute angular dimensions to investigators; hence the demand for telescopes with unprecedentedly high angular resolution--the ability to distinguish fine angular detail.

Being so enormously energetic, quasars must have correspondingly great mass. Yet if they are ultracompact as well, they must therefore be superdense. The most viable theoretical constructs meeting these properties are the so-called black holes. Indeed, detecting the disks of matter that should accrete onto black holes, if such exist, would be a major objective of the Ground-Space Telescope formed from the RADIOASTRON project. Black holes might have remained mere mathematical abstractions had radio astronomers not enhanced their likelihood by discovering ultradense matter in objects called pulsars. Pulsars are the final state to which matter collapses when massive stars cease producing energy internally. The resulting dead remnants confirm that truth is stranger than fiction. They are small enough to fit inside a city's boundaries. In addition, they consist of pure superconducting nuclear matter and may spin several hundreds of times per second. Their magnetism can be trillions of times that of the Earth or sun. These properties, unlikely ever to be duplicated in terrestrial laboratories, place pulsars squarely at the forefront of physics research. Their angular sizes, though, are much too small for existing telescopes. A Ground-Space Telescope, however, might be able to discern features in the magnetospheres around pulsars. Even if the pulsars themselves prove too small to permit precise images to be created, the scintillation (or "twinkling") of their visages will reveal details about the plasma between the stars.

Masers, the microwave versions of optical lasers, form a third class of cosmic objects unknown before radio astronomy. They result when a huge collection of identical molecules is induced collectively to make a quantum jump in energy state, thereby producing a highly directional beam of concentrated energy. Nature evidently orchestrates such coherent behavior with relative ease: several gigantic concentrations of water, methanol, ammonia, and hydroxyl molecules behaving in this way have been found. Their locations coincide with regions where stars are forming. When such regions are studied with sufficient angular precision, the spots where individual stars are being born come into focus. Existing telescopes cannot study the detailed structure of any one of them; antenna separations exceeding the Earth's dimensions are called for.

Quasars, pulsars, and masers are intensely interesting in themselves. They are also located at different distances and partake in various systematic motions under way in the universe.

Consequently they can serve as reference beacons to help calibrate distances and motions at various places in the universe and at various times in its history. RADIOASTRON will create a Ground-Space Telescope that will pinpoint their locations and motions with greater accuracy then ever before. It will therefore refine our notions of the universe's fundamental scale.

The importance of these findings goes far beyond the observatory. Previous refinements of this nature made over several centuries have helped humans comprehend their place within the universe. That, in turn, has profoundly influenced humanity's cultural heritage. Significant advances in these ongoing radio astronomy efforts are likely to have comparable impact.

Building a Telescope Larger than Earth

Radio astronomy owes its ability to discern finer structures than any other branch of astronomy to a technical tour de force. An inescapable rule of optics relates a telescope's size, measured in wavelengths of the radiation it observes, to its ability to distinguish individual radiating spots that are very closely spaced in angle as clearly separated features instead of a single blur. In other words, to sharpen an image one can either construct larger telescopes or use shorter wavelengths. Since radio wavelengths are the longest in the electromagnetic spectrum, radio astronomy's telescopes must be the largest if they are to compete with the telescopes used in other branches of astronomy. But only their outermost dimensions need be large; the total aperture of the telescope between its outermost extremities need not be filled completely. Consequently, radio astronomers have devised ways to link physically separated antennas into single telescopes. The technique, called interferometry, has succeeded magnificently. By applying it to antennas separated by ever greater distances, radio astronomers have made maps containing ever finer detail.

Once two antennas of a radio telescope are separated by distances approaching the Earth's diameter, however, few astronomical objects are visible to both antennas for a useful period of time; a given target object has either set beneath the western horizon of one observatory or has not yet risen above the eastern horizon of the other. Sharper observations that penetrate to smaller structures require distances between antennas even greater than the Earth's diameter.

This objective has been achieved in two different experimental tests using the National Aeronautics and Space Administration's (NASA's) Tracking and Data Relay Satellite (TDRS) as part of an array of antennas. The other antennas in the array were ground based. The combination of antennas produced a radio telescope with an effective size, as far as its ability to resolve detail is concerned, more than twice as great as the Earth's diameter. At the distance of a typical quasar, this translated into an ability to distinguish features separated by only a few dozen light years (the distance from the sun to some of its nearest neighboring stars, a trivial span to an astronomer). The proposed RADIOASTRON satellite would have even greater resolving power than TDRS, both because it swings into an orbit extending farther from the Earth and because it uses shorter wavelengths.

The sensitivity of a Ground-Space Telescope Larger than Earth is a second vital technical consideration facing RADIOASTRON. Weak signals often are weak because they originate at vast distances; and since they originate at vast distances, they have been traveling for a long period of time. Thus astronomers, both to determine the full depth of the universe and to detect changes in it over the eons, have probed deeper and deeper into space by studying weaker and weaker signals. This continuing quest for greater sensitivity to weaker signals is more difficult for widely separated but electronically linked antennas. This is because the total signal from, say, a distant quasar is itself weak, and, worse, only the fraction of it that originates from the most concentrated part is detectable by antennas integrated into an interferometer. The sensitivity of an interferometer consisting of two individual antennas can be improved by enlarging either one. This flexibility is particularly important when one of the antennas is to be placed in orbit, since the larger and heavier a payload, the more difficult and expensive it is to launch into space. As long as the ground antennas to which they are linked are big enough, however, the antennas feasible to launch today will produce the degree of sensitivity required. At the same time, the entire history of astronomy demonstrates that a degree of sensitivity deemed satisfactory today will be totally inadequate tomorrow. And astronomers know exactly how much improvement can be expected by a given enlargement of a ground antenna. Each doubling in diameter also doubles the interferometer's sensitivity; cuts the threshold of signal detectability in half; increases the range at which these threshold radio signals can be picked up by the 40 percent; and nearly triples the number of radio sources available for study.

Creating high-quality radio images of cosmic sources requires one other capability, namely, the detection of faint objects in the immediate vicinity of bright ones. The problem resembles one that photographers face whenever part of their subject matter is in bright sunlight and part in deep shadow. In the case of an array of connected radio antennas, the solution is to pack as many different antennas as possible within the telescope system's overall dimensions, to achieve the maximum number of intermediate separations. In the 1960's, the first ground arrays of radio telescopes consisted of pairs of antennas that could be separated by at most a few kilometers. In response to the demands of the science, these primitive arrays evolved in just two decades into one consisting of twenty-seven antennas spanning up to forty kilometers. By analogy, plans for orbiting antennas should presuppose that eventually, perhaps even rapidly, several will be aloft simultaneously.

The Specifics of RADIOASTRON

RADIOASTRON is an approved, funded project. Construction of the space antenna has been under way since early 1987. Because the project has moved far beyond the planning stage, decisions about participation are urgent. Several nations, including The Netherlands, Australia, West Germany, Finland, India, and Canada, are already contributing, but the Soviet Union is investing the most time and resources. The first phase of the plan will culminate with the launch of the first space antenna, presently (perhaps optimistically) scheduled for 1993. The antenna, ten meters in diameter, will be placed in an elliptical orbit whose closest approach to Earth will be 9,000 kilometers (about 5,600 miles) and whose most distant will be 75,000 kilometers (more than 46,000 miles). An orbit this size will eventually permit a range of antenna separations to be sampled, with the consequent advantages for dynamic range referred to previously. The antenna will carry instruments to study cosmic objects at wavelengths of 92, 18, 6, and 1.3 centimeters. These wavelengths have been chosen to offer a sizable range of angular resolutions, to match the specific radiating wavelengths of the most common cosmic masers, and to probe to different depths within quasars. (Shorter wavelength radiation originates deeper within a quasar.)

The orbiting antenna will receive signals from a preselected cosmic radio source. Other components needed to complete a telescope larger than the Earth are at least one, but preferably

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several, ground antennas looking simultaneously at the same targeted radio source; a ground-based control center for orienting the orbiting antenna and for establishing its orbit; communications links between the ground and space antennas for sending reference signals up and data down; tape recorders for collecting the data from the space and ground antennas and a processing facility for combining both sets of data; and post-processing computing facilities for converting combined data into astronomical images.

The description to follow of RADIOASTRON's various components conveys the project's completely international flavor and demonstrates a genuine Soviet commitment to conduct scientific research in full partnership with other nations. The United States has an opportunity to demonstrate that it, too, can participate in multilateral scientific ventures without insisting on a lead role. If all involved nations, in fact, contribute in the manner described below, the resulting Ground-Space Telescope acquires a global identity; it is not identified as any single nation's project.

The space antenna is being constructed by Soviet personnel. A primary requirement for any interferometer is knowledge of the precise orientation of the imaginary line between the individual component antennas. In the case of a ground-space interferometer, the necessary precision demands accurate determination of the space antenna's locations at all times. The FOMI Satellite Geodetic Observatory of Hungary has been given responsibility for this determination.

The orbiting antenna is merely a mirror that collects and focuses radio-frequency energy to a single point. Its usefulness is determined by the quality of the amplifying devices located at the focal point. The amplifiers for boosting the weak cosmic signals collected by the space antenna each have a different source: for the wavelengths of 1.3, 6, 18, and 92 centimeters, the suppliers are, respectively, the Helsinki University of Technology, the Netherlands Foundation for Radio Astronomy, Australia's Commonwealth Scientific and Industrial Research Organization, and the USSR's Space Research Institute (IKI). Originally, America's National Radio Astronomy Observatory (NRAO) was asked to construct the 1.3 centimeter wavelength amplifiers. But NRAO's March 17, 1987 request for an export license was denied by the Office of Munitions Control, Department of State, on June 2, 1987, prompting Moscow to turn to engineers from

Finland. Yet on June 6, 1988, only five days after the signing of a Joint U.S.-USSR communique on space cooperation, Roald Sagdeev, then director of IKI, appealed again to NRAO for assistance in fabricating the 1.3 centimeter wavelength amplifier. His was, in fact, the first specific request under the new superpower agreement. Accordingly, NRAO submitted a proposal to NASA for funding the necessary amplifier development effort. No official response has been received. In the meantime, the Helsinki University of Technology's development work has progressed toward completion. It has become too late for NRAO to provide an amplifier for the spacecraft. Failure to grant an export license did not handicap the Soviet Union. It instead forbade American scientists and engineers from enhancing their know-how by learning to produce space-qualified hardware. Since RADIOASTRON is only the first step in the development of Radio Telescopes Larger than Earth, the amplifier development by the National Radio Astronomy Observatory still remains vital. NRAO could, if funding became available soon, contribute amplifiers for various Soviet ground antennas as well as for a Japanese space antenna.

Ground antennas will include both new and existing stations. The NRAO has offered part-time use of its 140-foot radio telescope in West Virginia, its Very Large Array in New Mexico, and its Very Long Baseline Array, presently under construction but designed to offer ten antennas distributed widely across the entire United States. None of these facilities can be dedicated full-time to RADIOASTRON, however, since each is a multipurpose instrument serving many users. Major European telescopes--in West Germany, the United Kingdom, Italy, The Netherlands, and Sweden--will also be made available part-time, as will telescopes in Japan and Australia. The Giant Meter-Wave Radio Telescope, presently under construction in India, will provide the largest signal-collecting area for the observations at a wavelength of 92 centimeters.

Though by no means exhaustive, the list shows that a mechanism will be needed for coordinating the use of a multinational group of telescopes, each of which is already in great demand. It is apparent that the space antenna can be linked to these oversubscribed ground antennas for only short periods of time. The Soviets have responded to this problem by building a large antenna in the Uzbek Republic that can be committed to ground-space operation for as much of the time as both it and the orbiting antenna can commonly view a particular radio source.

But to make full-time use of the space antenna, another dedicated ground antenna on the side of the Earth opposite Soviet Central Asia should be constructed. If larger than those now available in the United States, this antenna--which could be built for about twenty percent of the cost of the space antenna--would also improve the sensitivity of the linked interferometer. This is precisely the type of U.S. contribution that would emphatically signal a commitment to space-science cooperation regardless of a project's country of origin. The National Radio Astronomy Observatory has proposed to the National Science Foundation construction of a very large, fully steerable radio telescope, operable at the necessary frequencies, to be placed within the National Radio Quiet Zone at Green Bank, West Virginia. If funded and promptly constructed, this telescope would be central to RADIOASTRON and all future Ground-Space Telescope missions.

A ground station supporting the orbiting telescope will send commands for orienting it. Since these commands need not be sent continuously, a single station is adequate. One exists in the Soviet Union, and it suffices to act as Mission Control Center.

Additional communications with the spacecraft will be necessary, though. In particular, clocks and signal generators onboard the spacecraft must be slaved to ultraprecise standard devices, which can operate optimally only in a ground-based laboratory. These reference signals must therefore be transmitted from the ground laboratory to the spacecraft. Likewise, signals collected by the space antenna from a cosmic radio source must be transmitted from space to Earth. There, with time marks accurately superimposed, they must be magnetically recorded for eventual playback through a special computer. In it the signals from the space and ground antennas are aligned according to the series of time marks on each and then cross-compared.

To carry out the dual functions of transmitting reference signals to the spacecraft and receiving a real-time data stream from it, a modestly sized ground antenna is needed. Only when the spacecraft is in line-of-sight contact with such a ground station can the cosmic data received by the space antenna be recorded. The main communications station will be in the Crimea, but RADIOASTRON's orbiting antenna will not be in line-of-sight contact with it at all times. Some help might be forthcoming from the satellite communications antennas of NASA's Deep Space Network (DSN), but access to these devices will depend on DSN's other responsibilities. Being able to acquire but not record uniquely valuable data represents a glaring inefficiency. Thus another significant--and inexpensive--contribution that the United States could make to RADIOASTRON and its successors would be the addition of a two-way, ground-satellite communications antenna. The scientific usefulness of this communications antenna would be enhanced if it were co-located with the very large ground-based radio telescope proposed earlier.

Radio telescopes acquire so much data so quickly that they require sophisticated recording devices. Commercial magnetic tape units must be specially modified to meet the required specifications. Further, the data must be properly formatted if they are to be read by the special processing computer. The NRAO is constructing several new recording terminals for its Very Long Baseline Array (VLBA). Their primary virtue will be their ability to record wider slices of the electromagnetic spectrum than their forerunners. Collecting a broader signal in this way makes the array more sensitive. Conversely, arrays that do not rely on these wide-band terminals perform less effectively.

NRAO is also constructing the processor, or special-purpose computer, for combining the signals recorded by the elements of the VLBA. This processor is specifically being designed to accommodate simultaneously more than the ten VLBA antennas. Some of the additional antennas could be in space, so the resultant array could be larger than global. In fact, NRAO has committed part-time use of its tape processor to the RADIOASTRON project. The free exchange of scientific data from space is in line with U.S. and Soviet policy as codified by signed cooperative agreements. U.S. scientists view these data as the most valuable resource the Soviet Union could provide them.

The sets of data exchanged, however, must have the same standardized format before any processor can correlate them. Moscow has therefore asked NRAO to provide VLBA terminals for storing data at its ground antennas and at the communications antenna receiving data from the space antenna. In early 1988, in response to an NRAO inquiry, the Commerce Department indicated verbally that it would not approve the necessary export license, so none was officially requested. Recently (1989) NASA has indicated it may add its weight to such a license request, but the outcome remains unpredictable. The resulting uncertainty has caused RADIOASTRON's project managers to seek recording devices elsewhere. Canada has agreed to provide them. The Canadian design would introduce a different format for the data recorded on tape, however. If adopted, the VLBA antennas and the VLBA processor would be incompatible with the RADIOASTRON space antenna. In that event, the United States would not reap the maximum benefit from its considerable investment in its own telescope array. We can either seize a golden opportunity to assert international scientific leadership by improving the technical performance of the world's first full-time Ground-Space Telescope, or we can undermine both it and our own new telescope array. America's refusal to help out hampers its own future progress in a scientific field it has led since its inception.

Partial and inferior solutions can perhaps be found to the tape recorder problem. For example, a special-purpose device could perhaps read signals in from Canadian-produced tapes and write them out in American-standard format. The "Rube Goldberg" nature of this step is readily apparent. More importantly, the two-way communications antenna proposed earlier becomes essential if high-density recording devices cannot be exported to the USSR. For the Soviets have agreed to transmit data acquired by the antenna in space directly to such a communications station. A recorder there salvages at least part of the unique cosmic data picked up by the RADIOASTRON satellite.

Once the data from all antennas involved in the array have been cross-compared or correlated, further stages of data analysis are needed to produce images that are the equivalent of a photograph. The computer programs for these postprocessing steps are already found all around the world. Eventually, however, greater computer capacity may be needed.

The Role of U.S. Government Agencies

We have presented examples where U.S. indecisiveness regarding RADIOASTRON has permitted other nations to assume the role that naturally befell us. With remaining time so very short, any further delay could cause the United States to miss the boat entirely. What Washington needs to do immediately is to commit to participation in RADIOASTRON. Throughout the history that culminated in the operation of a global array of radio telescopes, such decisions were settled by scientists of the countries involved. Americans often led the way in creating a truly global array. They see the step into space as the logical next phase of this undertaking and want to proceed immediately. But today, as already indicated, technology transfer and consequently national security concerns are intruding.

Concerns over these issues are misplaced. They mistakenly assume that all transfers in the RADIOASTRON project are one-way, from the United States to the Soviet Union. In point of fact, we have as much to learn from the Soviets about manufacturing space-qualified hardware as they from us. Then, too, as already mentioned, the Soviets are willing to transfer the space-acquired data--the purpose of the entire project--to us. Forbidding transfers of technology also assumes the U.S. alone can provide the requested components. The cited experiences with amplifiers and tape recorders demonstrate that this assumption is false. The amplifier design is standard, has been published in the technical literature, is well known throughout the international radio astronomy community and has been adopted by Finnish engineers. The VLBA recording terminals use commercial Honeywell tape recorders, whose recording heads alone are modified. To illustrate that the recording technology is not so advanced that it conveys a national security advantage, note that the alternative recording scheme proposed by the Canadians uses several everyday television VCRs, ever so slightly modified. That a self-imposed hurdle may shut the United States out of RADIOASTRON, to the detriment of both U.S. and international science, is intolerable. Washington should move quickly to approve transfers of the required technologies.

As envisioned, RADIOASTRON will integrate people, agencies, telescopes, electronics devices, satellite communications networks, computer programs, and more into a single telescope bigger than the planet--one that can justifiably be labeled a Solar System Telescope. The complexity of achieving this integration cannot be underestimated, and the backbone of the integrating process will be communications. These must be frequent and open, and should be conducted on a person-to-person, scientist-to-scientist basis rather than between governments. The participating scientists recognize that their field advances by the vigorous and free exchange of ideas. Nothing has contributed more to the advancement of American science; nothing has crippled Soviet progress more than its past obsessive secrecy and political interference. American radio astronomers would like to extend their country's established tradition of unrestricted scientific exchanges to their newly responsive Soviet colleagues. They view RADIOASTRON as their first opportunity to do so and ardently hope for approval from the new administration.

RADIOASTRON and U.S.-Soviet Relations

RADIOASTRON should be viewed as an opportunity to test both U.S. and Soviet sincerity regarding space-cooperation agreements. It can serve as a confidence-building measure for both sides, one that can pave the way for such more ambitious missions as joint explorations of the planets. These latter missions will seem out of the question if simpler--that is, less costly and less newsworthy--joint projects cannot be realized. RADIOASTRON also presents the United States with an opportunity to contribute significantly to a major international scientific project, and to reap all the good will that would flow therefrom--all with a minor share of RADIOASTRON's total expenses. If Washington passes up this chance to "free-ride," RADIOASTRON will go forward anyway; the United States will reap only ill will, and its scientists will have been excluded from an opportunity they bore large responsibility for creating.

The impetus for a cooperative Space-Ground Telescope project has come from two directions: from the bottom up, as the next logical step for an international scientific community that has extensive experience at working together and whose mutual interests happen to coincide; and from the top down, as the immediate consequence of cooperative space agreements signed by U.S. and Soviet leaders. Every Reagan-Gorbachev summit has included a discussion of possible joint space activities. Obviously, these issues are relevant not just to the special-interest group of space scientists but are central to both nations' foreign policies. And after every signed cooperative space agreement, the Soviets have suggested specific ways that Americans could enhance RADIOASTRON. This particular project is evidently very important to Moscow.

Moreover, the Soviet's willingness to invite international cooperation on their priority space activities is unprecedented. Yet being so new, this refreshing change of outlook is fragile and needs careful nurturing by the rest of the international community. If America responds positively by offering to RADIOASTRON its best efforts and technology, the spirit of *glasnost* (openness) will be reinforced. But if America, alone among invited nations, turns the Soviets down or withholds its most valuable technology, its international image will surely be tarnished.

This almost Brezhnevian policy would contradict America's tradition of encouraging the rapid advancement of knowledge by promoting the uninhibited exchange of ideas. And it would forfeit U.S. scientific leadership in a field that Americans have drive to its present state of excellence.

The Internationalization of Radio Astronomy

The promise of RADIOASTRON is greater than the launch of a single antenna into space, which is just the first step toward enhancing sharpness of radio images. Other nations will launch space antennas as well. If intelligent cooperation is nurtured from the beginning, every additional antenna in space can enhance existing capability. There is no need for NASA to prefer one project over another, since they are not in competition. Each only adds to its predecessors.

VSOP, which stands for VLBI Space Observatory Program, is a Japanese proposal in the same vein as RADIOASTRON. The Japanese telescope in space will be put into an orbit that complements those of the other missions. VSOP is the highest priority for new starts by Japan's Institute of Space and Aeronautical Science (ISAS). Launch of the antenna into space could occur in 1995. As with RADIOASTRON, extensive cooperation with other countries is anticipated.

Both of these orbiting antennas have projected useful lifetimes of about two years. Consequently it is not too early to begin planning their successors. The Soviet Union intends to follow the first RADIOASTRON space antenna with one operable at millimeter wavelengths sometime between 1996 and 2000. Since the resolution limit of a ground-space telescope is determined by how many wavelengths fit across the spacecraft's orbit, shrinking the observable wavelength by a factor of ten yields an equivalent gain in resolving power. The third phase of Soviet exploration, for the years 2001 to 2005, calls for three antennas, each thirty meters in diameter, to be simultaneously in vastly different orbits: one in a geostationary orbit, a second in a twenty-seven-day elliptical orbit, and a third at a stationary point some 1.5 million kilometers from Earth.

It is apparent that early in the next century a true Solar System Radio Telescope will connect perhaps six antennas in carefully chosen orbits with a superarray of ground antennas distributed optimally over the Earth's surface. The space antennas will be about three times larger in diameter than the original RADIOASTRON antenna, and will operate at wavelengths one-tenth as long. No one nation will contribute all of the space antennas; the United States should expect to contribute two. All the steps mentioned previously--continued amplifier development, two-way communications antennas, a large ground antenna, and high-density tape recorders--are on an evolutionary path toward this development. They therefore represent extremely cost-effective investments: not only are they small fractions of the cost of orbiting antennas, but also their productive scientific payback period is long.

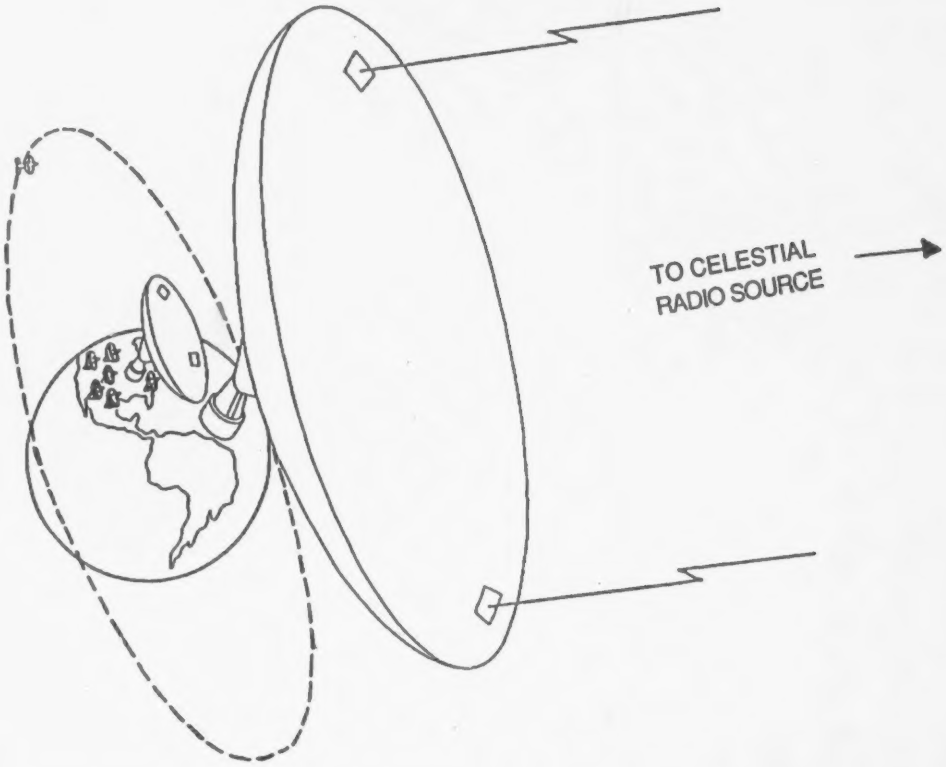
Three decades of space exploration have driven home the message that, in the most important respects, Earth is a unit, an indivisible entity. Because of this internationalist--even nonnationalist--message, it seems absurd to conduct investigations in space strictly as nationalist enterprises. And nowhere is this unity more evident than in the creation and operation of a telescope bigger than Earth. The ground portions of the envisioned Solar System Radio Telescope must be based in many different nations, while the spacecraft portion will pass above several of them. The data collected by the space antenna cannot be transmitted full-time to a single country, nor can the reference signals that the antenna relies on be provided continuously from only one country. The entire operation must be truly multinational. If it is successful at all, a synthesis will have taken place that transcends national identities, and a new International Space VLBI Institute will be needed to operate the whole. The cosmic objects observed by the total array dwarf the Earth both in size and age and serve as the most graphic possible reminders of mankind's true place in the universe. Surely humans can perceive that the grandness of what envelopes them trivializes the differences that drive them apart. At the least they must cooperate in the investigation of that grandness.

With RADIOASTRON and the similar missions sure to follow it, scientists from several nations can cooperate in one phase of that investigation. Further, if these joint radio astronomy endeavors are successful, the door will be open for many other proposed scientific projects whose magnitude exceeds the capability of any single nation. Some examples are the Superconducting Super Collider, Human Genome Mapping, the Human Frontier Program, the

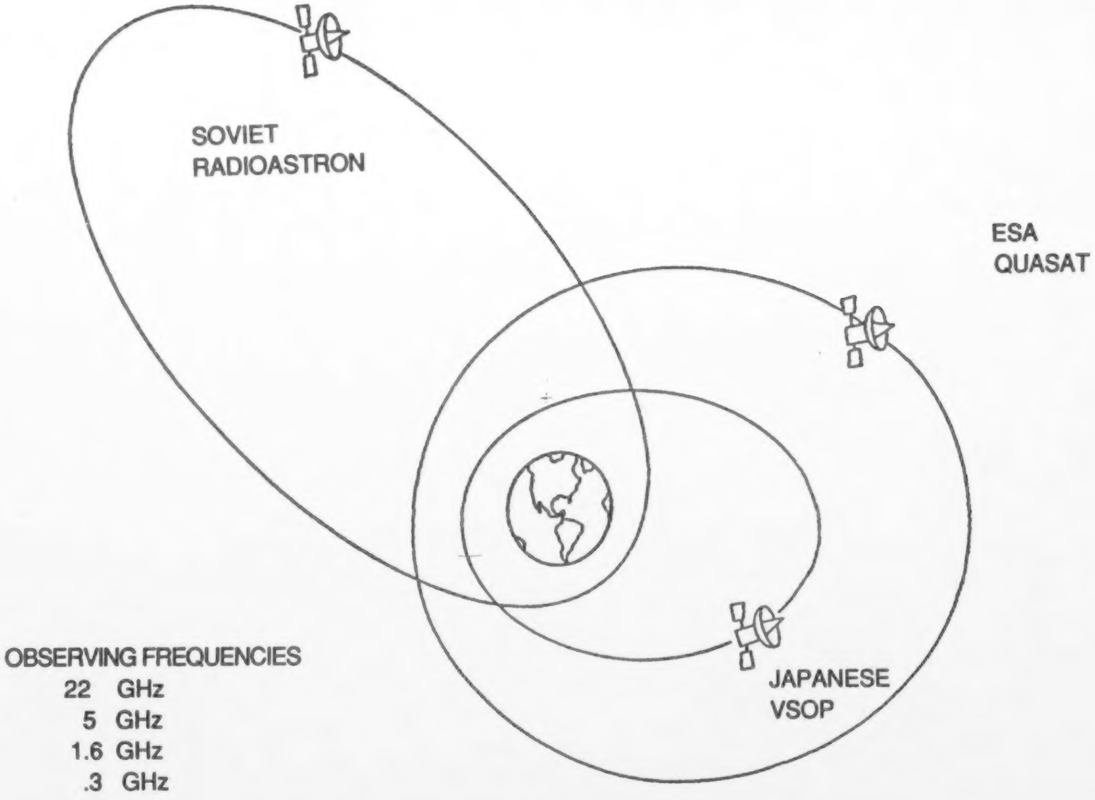
International Geosphere-Biosphere Program, and AIDS research. Cost considerations alone dictate a multinational approach. But more important, these investigations demand the best intellects available. And no country has a monopoly on keen intellect, or its extreme manifestation, genius.

If the world is ever to face planetary challenges collectively, then each nation must help every other to maximize the good that could flow to all. The United States has an opportunity to strengthen the RADIOASTRON project considerably. If it seizes the opportunity, Space VLBI may emerge as a model for conducting science in a wholly new way--as a global enterprise.

SPACE VLBI: SYNTHESIZING ANTENNAS LARGER THAN THE EARTH

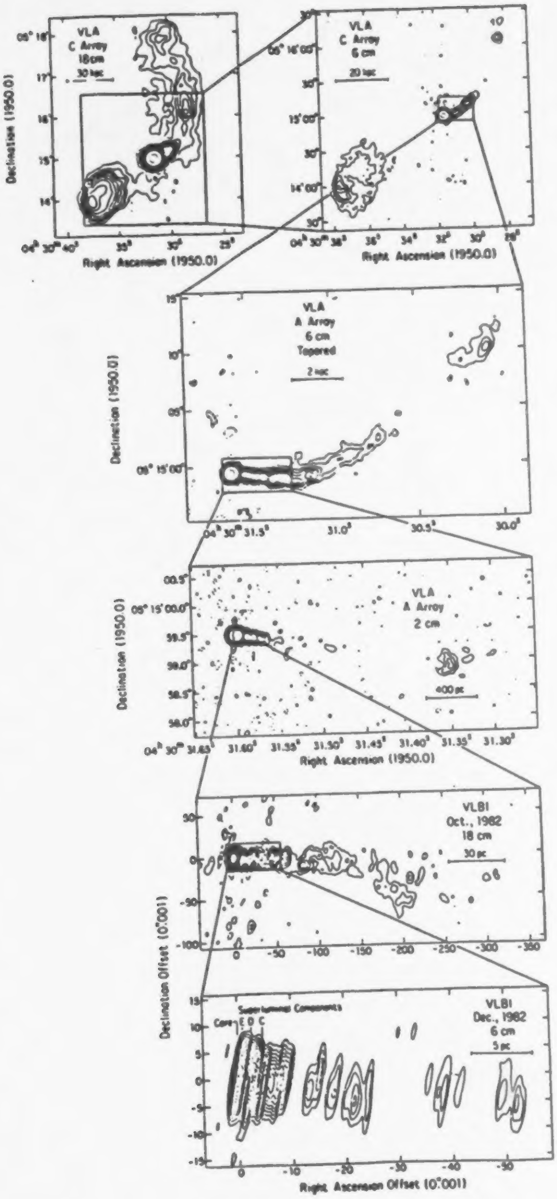

TO CELESTIAL
RADIO SOURCE

SPACE VLBI MISSIONS IN THE 1990'S


SOVIET
RADIOASTRON
ESA
QUASAT
JAPANESE
VSOP

OBSERVING FREQUENCIES
22 GHz
5 GHz
1.6 GHz
.3 GHz

Space VLBI missions complement one another.

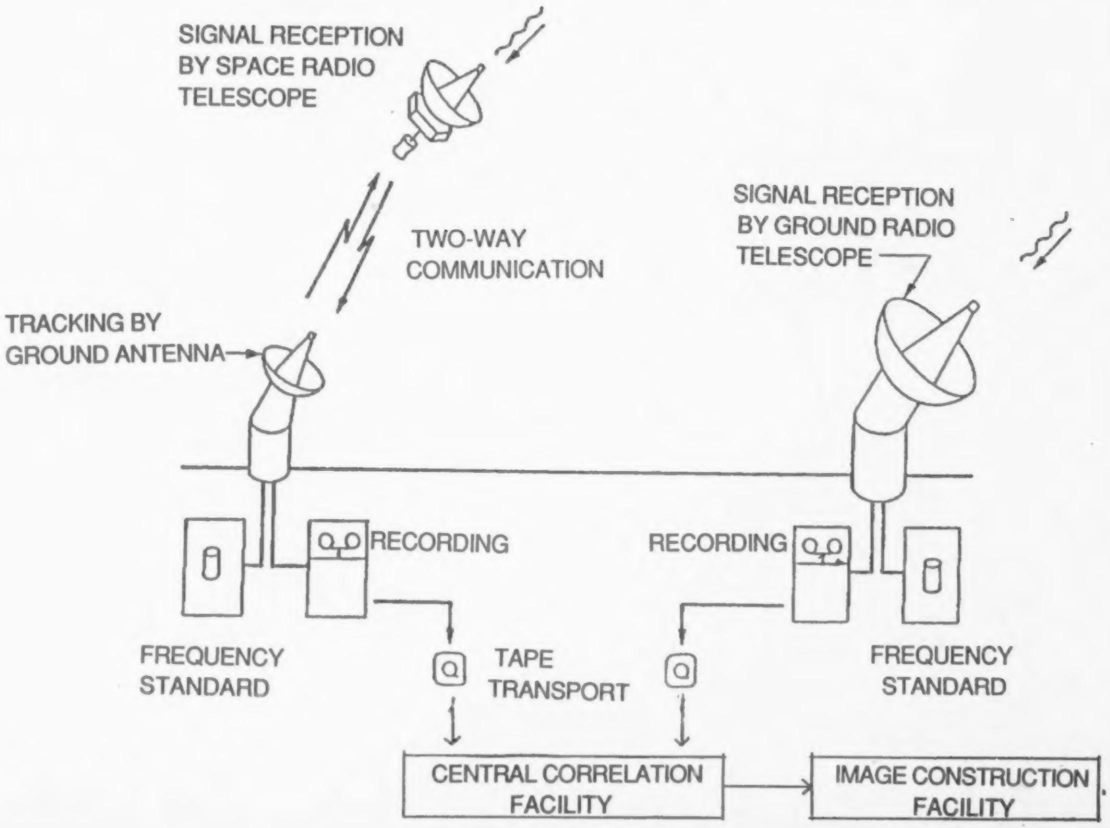


Each detailed image penetrates deeper into the core.

The ultimate energy source, though, is still hidden.

Space VLBI may uncover it.

DIAGRAM OF A SPACE-GROUND VLBI SYSTEM


SIGNAL RECEPTION
BY SPACE RADIO
TELESCOPE
TWO-WAY
COMMUNICATION
SIGNAL RECEPTION
BY GROUND RADIO
TELESCOPE
TRACKING BY
GROUND ANTENNA
RECORDING
RECORDING
FREQUENCY
STANDARD
TAPE
TRANSPORT
FREQUENCY
STANDARD
CENTRAL CORRELATION
FACILITY
IMAGE CONSTRUCTION
FACILITY

Mr. **Nelson**. Thank you. Dr. Blanchard.

Dr. **Blanchard**. Thank you, Mr. Nelson. It's a pleasure to be here. I'll be very brief.

You've heard testimony yesterday and this morning about the importance of an international concept called Mission to Planet Earth. I worked in this field for the past three or four years and I want to say, although I was trained as an astronomer, like Dr. Seielstad, looking out at the rest of the universe, I've been concerned the last few years looking down at the Earth, and I've been impressed with how important it is for us to continue to build toward space missions to look at the Earth.

Up to now, even though the study of the Earth is inherently international, up to now the United States and the Soviet Union have not yet cooperated in the study of the Earth from space. I think it's time to take that step, and I'm proposing that the United States and the Soviet Union each construct and place into polar orbit a research satellite or space platform for the global study of the Earth, concentrating particularly on changes in the global environment of the Earth.

Now, you might ask how can this be done most expeditiously, and one way is to look at the structure of the Mission to Planet Earth concept itself. The centerpiece of that concept is a NASA project called the Earth Observing System. I'm sure you've had testimony about that. Let me just remind you it consists of four spacecraft in polar orbit, two contributed by the United States, one by the Europeans, and one by the Japanese, to be placed into polar orbit in the middle 1990's and a bit later.

I believe we should invite the Soviet Union to participate in that program by contributing a platform, and the way it could be done in the context of this proposal, we could declare one of our platforms the counterpart to the Soviet platform and have a 50-50 responsibility for those two platforms. The two platforms could either carry out complementary observations, sort of one picking up where the other leaves off, or they could be functional duplicates and serve as backups. Either way, we would have an enormous increase in scientific data.

The timing is right politically. We've seen developments in the Soviet Union that represent an opening for this kind of initiative. The diplomatic work has been laid, and I think that if the Bush administration would confer with our allies in the Earth Observing System and with the Congress, there's an opportunity to take a step at a very high level, summit diplomacy, to make this offer to the Soviet Union and get this cooperative project rolling. I think we should take that step this year, and I hope this committee will support it.

Thank you, Mr. Nelson.

[The prepared statement of Dr. Blanchard follows:]

FPI POLICY BRIEFS

COMBINED REMOTE-SENSING OBSERVATIONS OF THE EARTH FROM SPACE

FOREIGN POLICY INSTITUTE
SCHOOL OF ADVANCED INTERNATIONAL STUDIES
THE JOHNS HOPKINS UNIVERSITY
WASHINGTON, D.C.

Combined Remote-Sensing Observations of the Earth from Space

Paul Adam Blanchard

With the Earth's environment undergoing unprecedented changes as a result of man's activities, obtaining a big picture on the global environment has become imperative. Fortunately, that picture is already coming together thanks to remote-sensing satellite technology. In collaboration with other Western countries, the United States has launched a vigorous remote-sensing program designed to study the Earth's environmental systems. And the Soviet Union maintains an active remote-sensing program as well.

To date, the superpowers' programs have proceeded along analogous but separate tracks. But U.S.-Soviet cooperation in this field could dramatically improve remote-sensing efforts, yielding important benefits for both countries and for the world they are fated to share. The most effective way to initiate such cooperation would be for each country to construct and place into polar orbit a research satellite or space platform designed for comprehensive study of global changes in the Earth's environment. The two satellites would each incorporate sets of remote-sensing instruments intended to carry out similar or complementary Earth observations.

Such joint remote-sensing efforts would enable the West to exploit demonstrated Soviet strengths in several relevant technologies, such as radar. Soviet participation in remote-sensing programs would also provide access to Soviet territory--a vast and ecologically crucial portion of the Earth's surface. And with each superpower retaining control of the instruments on their respective satellites, the West could easily guard militarily significant technology. The scientific data and images to be collected, moreover, would have no major intelligence value. A joint superpower remote-sensing project would therefore meet the requirements of any successful cooperative effort--timeliness, objective need, visible results, and mutual advantage.

The Environmental Crisis

The kinds of observations possible only from space are urgently needed, as man's activities are changing--and clearly threatening--the environment for life on Earth. Observed changes in the chemical composition of the Earth's atmosphere furnish perhaps the greatest cause for concern. The burning of fossil fuels, for example, is greatly increasing the atmospheric concentration of carbon dioxide. The heat trapped by this carbon dioxide (the so-called greenhouse effect) is producing a global warming trend. Moreover, carbon dioxide is only one of an entire class of greenhouse effect-producing gases--including methane, nitrous oxide, and industrially produced chlorofluorocarbons (CFCs)--whose atmospheric levels are rising even more rapidly. Current climate models predict that, if present trends continue, the average global surface temperature will rise by 2-4 degrees Celsius during the next century, generating the most pronounced climate change ever experienced by organized human societies.

The CFCs have gained additional notoriety because of their destructive effect on the Earth's stratospheric ozone layer, which shields terrestrial life from harmful solar ultraviolet radiation. Atomic chlorine released by CFC decomposition in the stratosphere is almost surely responsible for the annual, large-scale depletion of ozone over Antarctica (the "ozone hole") documented since 1979. Evidence for ozone depletion over the Arctic has recently been reported, too, and global ozone levels may already have been affected. Despite a 1987 international treaty that curtails CFC production, atmospheric concentrations of these long-lived chemicals will remain substantial for years to come.

Drastic global changes are occurring on land and in the oceans as well. The widespread destruction of tropical forests, for example, is altering the global biogeochemical cycles of key trace elements such as carbon, nitrogen, and phosphorus that are essential to life. The carbon cycle is particularly important because of the steady increase in atmospheric carbon dioxide. The world's oceans are major absorbers of this gas, but much remains to be learned about the critically important role of ocean life such as plankton in this process and how this life may be affected by abnormal carbon dioxide levels. The biogeochemical cycles of nitrogen, phosphorus, sulfur, and several other trace species are also being strongly perturbed by industrial and agricultural activity.

The atmosphere, oceans, and land surfaces of the Earth are closely linked through a variety of physical, chemical, and biological interactions. These interactions mingle the effects of natural influences (such as volcanic eruptions) with those of human activities (such as fossil-fuel burning or fertilizer use). Attempts to establish man's role in these global changes therefore requires an understanding of how the Earth operates as a total, unified system.

Yet such understanding is precisely what is lacking. No detailed knowledge of any of the important systemic interactions, such as the ocean-atmosphere interaction, has been gained. And next to nothing is known about the global influence of biology. Only space observations can provide the rapid, global, comprehensive view needed for research to progress.

Moreover, governments are recognizing that the study of the Earth is an inherently international endeavor. In response to the challenge of global change, for example, the International Council of Scientific Unions in 1986 endorsed an International Geosphere-Biosphere Program (IGBP) designed to investigate the processes that regulate the total Earth system and the attendant role of human activities. Both the United States and the Soviet Union plan extensive contributions to IGBP. The Soviet Union has also responded warmly to U.S. proposals to convene an International Space Year (ISY) in 1992. Improving understanding of the Earth as a planet is prominent among proposed ISY scientific objectives.[1]

Still, the United States and the Soviet Union have yet to cooperate in Earth remote-sensing from space. This vacuum is all the more surprising because the technical barriers to such cooperation are slight. Existing U.S. and Soviet national remote-sensing programs share some important similarities.

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[1] John McLucas and Harvey Meyerson, "Planning for the International Space Year," *Space Policy*, May 1988, 108.

U.S. Remote-Sensing Programs

American polar-orbiting weather satellites, now operated by the National Oceanic and Atmospheric Administration (NOAA), were the first systematic Earth remote-sensing devices to be placed into space.[2] Beginning in 1960 by broadcasting crude television images of cloud patterns, the NOAA polar orbiters have matured into powerful and sophisticated observing systems that provide information on atmospheric temperature and humidity, sea-surface temperature, ice and snow cover, and other planetary characteristics. Although originally sought for weather prediction, these data are now recognized to be essential also for the long-term monitoring of global environmental change. In addition, NOAA satellite data are needed for supercomputer models of atmospheric circulation, which are critical to the study of the Earth's climate. A U.S. geostationary weather satellite system, which complements the more detailed studies of the polar orbiters, has been in orbit since 1974.

In parallel with the NOAA operational weather satellites, the United States has conducted extensive space-based studies of Earth through the research missions of the National Aeronautics and Space Administration (NASA). Atmospheric, ocean- and land-surface properties have all been analyzed thoroughly. For example, in 1985 the Total Ozone Mapping Spectrometer (TOMS) aboard NASA's Nimbus-7 satellite played a decisive role in confirming the existence of the Antarctic "ozone hole" perceived earlier by ground-based observations. NASA's 1978 Seasat mission initiated systematic satellite study of the ocean and ocean-atmosphere interaction. The Landsat series of spacecraft, begun by NASA in 1972 to carry out multispectral imaging of the land surface, has permitted assembly of the first global maps of the Earth from space. Landsat-6, to be launched in 1991, will carry a Sea Wide Field Sensor for global studies of ocean biology as well as a high-resolution multispectral imager for land-surface investigations. Administration of the Landsat series is now being transferred from NOAA to private commercial management.

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[2] *Space-Based Remote-Sensing of the Earth: A Report to the Congress* (Washington, D.C.: National Oceanographic and Atmospheric Administration of the U.S. Department of Commerce and the National Aeronautics and Space Administration, September 1987).

Due to increased recognition of the dimensions of global change, U.S. space-based Earth science has taken on an international dimension as well. Satellites to perform a new generation of jointly designed Earth-science missions will soon be placed in low-inclination orbits. The Ocean Topography Experiment, or TOPEX/Poseidon mission, now being developed by NASA and the French national space agency for launch in 1991, will return data essential for three-dimensional studies of global ocean circulation. The Upper Atmosphere Research Satellite (UARS), also to be launched in 1991, will carry out the first comprehensive study of upper-atmosphere chemistry, dynamics, and energy inputs, thereby helping to elucidate the complex mechanisms responsible for changes in the Earth's protective ozone layer. Although primarily a NASA mission, UARS will carry an international suite of instruments, and scientists worldwide will participate in UARS data analysis and interpretation.

But the long-term monitoring and study of global environmental change also requires a series of advanced, highly capable satellites in polar orbit--satellites that permit simultaneous operation of both research and weather instruments. The Earth Observing System (EOS), now under study by the United States, the European Space Agency (ESA), Japan, and other Western nations, is designed to meet this need. Present planning calls for four polar-orbiting platforms. The first two satellites, furnished by the United States and ESA, will be launched in 1995 and 1996 for multispectral imaging and environmental observations. The second pair of satellites, provided by the United States and Japan, will be launched in the late 1990s. They will extend UARS atmospheric observations and carry out surface studies with synthetic-aperture radar.

When supported by a constellation of geostationary Earth-observing satellites and ancillary ground-based observations, EOS will form the centerpiece of a more broadly based project ("Mission to Planet Earth") aimed at comprehensive study of the total Earth system by all available means.[3] The concept enjoys strong backing in the U.S. Congress and, under American leadership, is rapidly gathering international momentum.[4]

Soviet Remote-Sensing Programs

The Soviet Union Earth remote-sensing program involves four distinct classes of satellites in low-Earth orbit: photographic Earth resources spacecraft in the *Kosmos* series; the *Mir* space station, which supports a variety of cosmonaut-directed observations; weather satellites in the *Meteor* series; and specialized remote-sensing satellites for prolonged land, ocean, and atmospheric observations. All of these Soviet space missions are supported by aircraft observations and a network of ground- and sea-based test sites, representing an integrated system for environmental monitoring and Earth science research.

The remote-sensing missions carried out by the *Kosmos* spacecraft are variants of military photoreconnaissance satellites and utilize multispectral photography to map global agricultural patterns. Three such missions--*Kosmos* 1846, 1882, and 1906--were launched in 1987. *Kosmos* 1906, described as the first of a new generation of ecology-monitoring satellites, failed shortly after launch and was detonated in orbit to prevent uncontrolled reentry. But high-resolution photographs of the land surface returned by earlier spacecraft in this series are now being offered for sale to the West.

The Soviets also make extensive use of their manned space stations for Earth remote-sensing. Between 1977 and 1986, crews aboard *Salyut* 6 and 7 utilized two permanently installed cameras for multispectral imaging and contour mapping. *Salyut* 6 cosmonauts also used a submillimeter telescope with cryogenically cooled sensors for atmospheric research, primarily for studies of the ozone layer. A routine program of multispectral Earth photography continues on the present *Mir* space station, in orbit since 1986.

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[3] Burton I. Edelson, "Mission to Planet Earth," *Science*, vol. 227 (January 25, 1985), editorial; D. James Baker, "Mission to Planet Earth," *Aerospace America*, July 1988, 44.

[4] Craig Covault, "International Space Effort to Assess Earth's Environment," *Aviation Week and Space Technology*, August 22, 1988, 18.

The Soviets made their first weather observations from low-Earth orbit in 1965. Today's *Meteor*-2 spacecraft are placed into nearly polar orbits at altitudes of about 950 kilometers (560 miles) and have an active life of several years; they gather a wide range of surface-imaging and other meteorological data comparable to those obtained by their American counterparts. In July 1988, a weather satellite designated *Meteor* 3-2, the second of a new *Meteor* series was placed into a 1200 kilometer (740 miles) orbit, complete with an instrument for ozone measurements. The first Soviet geostationary weather satellite is planned for launch before the end of this decade.

The Soviets have also orbited long-duration, unmanned satellites specifically designed to carry out such remote-sensing tasks as natural-resource surveys, geological research, land-use planning, and mapping. Satellites in one series, begun in 1977, are roughly analogous to the U.S. Landsat spacecraft, and carry out multispectral digital imaging in a variety of visual and near-infrared spectral bands. *Meteor* 1-30, in orbit since 1980, continues to return good images. The most recent launch in this series, *Kosmos* 1939, occurred in April 1988.

A second series of dedicated remote-sensing satellites, begun in 1979 under the *Kosmos* designation, is intended primarily for oceanographic observations and conducts radar studies as well as multispectral imaging. *Kosmos* 1869, launched in July 1987, has produced excellent images of land and ocean features, although its radar antenna could not be activated. *Okean*-1, the most recent satellite in this oceanographic series, was launched in July 1988.

Kosmos 1870, launched 9 days later than *Kosmos* 1869 and estimated to weigh more than 15 metric tons, carries advanced radar and optical systems and represents a significant expansion of Moscow's Earth-observation capabilities. Future satellites in this third series of Soviet spacecraft could presumably accommodate international remote-sensing instruments. And in April 1988, *Kosmos* 1940 became the first dedicated Soviet Earth-observing satellite to be placed in geostationary orbit. Clearly, the Soviets are ready technologically to participate in international remote-sensing programs.

The Long Record of Superpower Space Cooperation

U.S.-Soviet space cooperation is well into its second decade. An accord signed in 1972, for example, laid the foundation for the 1975 joint Apollo-Soyuz manned mission in low-Earth orbit. Although the United States allowed this agreement to lapse in 1982 following the imposition of martial law in Poland, that year nevertheless saw establishment of an international Search and Rescue Satellite System (COSPAS/SARSAT) aboard U.S. polar-orbiting weather satellites and USSR navigation satellites. So far this system is credited with saving the lives of more than 1,000 sea-going accident victims.

Mikhail Gorbachev's rise to power in the Kremlin has increased prospects for U.S.-Soviet cooperation in space exploration, scientific research, and Earth remote-sensing beyond any levels that could reasonably have been anticipated during the first Reagan administration.[5] Indeed, his *glasnost* (openness) campaign has already produced an impressive list of milestones in international space cooperation.

In March 1986, spacecraft from the Soviet Union, Europe, Japan, and the United States carried out the first detailed study of Comet Halley. During the historic encounter and data-return phase, Moscow hosted an international gathering of scientists and journalists and provided them with unprecedented access to Soviet facilities and personnel.

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[5] Joan Johnson-Freese, "Changing Patterns of International Cooperation in Space: The Soviet Factor," *Space Policy*, February 1988, 24.

The following February, the United States and the Soviet Union prepared proposals in support of the U.S.-led International Space Year in 1992. Both nations called attention to opportunities for expanded scientific studies of the Earth during ISY. That April, the superpowers signed a new space cooperation agreement, renewing the spirit of cooperation established in 1972 during the period of detente. An appended list of 16 proposed cooperative projects included "coordination of activities in the study of global changes in the natural environment."

As previously mentioned, in July, 1987 the Soviets began to market multispectral images of the Earth's land surface taken from space through their new *Soyuz Karta* satellite-mapping organization. The five-meter resolution of the Soviet photographs was more detailed than that provided by the current civil remote-sensing systems of either the United States or France.

In October 1987 the Soviet Union held an international Space Future Forum to commemorate thirty years of space exploration, drawing over 800 delegates from around the world. The head of the Soviet Academy of Sciences' Space Research Institute used the occasion to urge increased international cooperation in space.

That same month, after thirty years of the strictest secrecy, the Soviets opened their space launch sites to inspection by potential foreign commercial launch-service customers.

And in 1988, the pace of cooperation accelerated. In April, representatives of the space agencies of 17 nations, including the United States and the Soviet Union, met in New Hampshire to plan International Space Year activities; a Mission to Planet Earth emerged as a central ISY scientific focus. A follow-up meeting was held in Finland in July to begin coordinating the ISY program in detail.

May saw Washington and Moscow agree to participate in an international study of the ozone layer over the Arctic in early 1989. Aircraft from both nations will collect data in areas of ozone depletion, marking the first Soviet involvement in coordinated ozone experiments. That month, Moscow also for the first time permitted a large group of American journalists to visit the Baikonur Cosmodrome near Tyuratam in Soviet Central Asia. The newsmen witnessed the launch of the *Kosmos* 1944 Earth-mapping satellite aboard an SL-4 rocket. A high-level U.S. Air Force delegation toured Baikonur two months later. Moreover, at their Moscow summit Gorbachev and President Reagan agreed to permit each country's scientific instruments to fly aboard the other's satellites. Of particular importance will be the scheduled flight of the U.S. Total Ozone Mapping Spectrometer (TOMS) aboard a USSR *Meteor* weather satellite, which will provide global maps of stratospheric ozone concentrations.

And in August, the Soviets hosted an international meeting to discuss the International Geosphere-Biosphere Program (IGBP), which will draw extensively upon satellite data from the Mission to Planet Earth project.

Making Cooperative Remote-Sensing Work

Yet for all this progress, a bold initiative is still needed to extend the international study of the Earth during the 1990s. The project proposed here, U.S.-Soviet cooperation in remote-sensing from space through launch of counterpart satellites or space platforms would fill the bill. The observations of atmospheric, ocean, and land-surface features that could be made by these spacecraft will continue to contribute enormously to the study of global changes in the environment.

Moreover, each country has the capability to implement this project at once, and the motivation to do so. As a result, the program will meet the pressing need for new observations during the next decade, and consequently to make major budget decisions during the next two years. For example, NASA has proposed starting work on the EOS system in fiscal year 1991. In fact, launching counterpart satellites would entail a channeling of present programs into new, politically rewarding directions, and avoid the risks of starting new programs from scratch.

Since no change in technological directions is required for either country, and there will be little if any opportunity for technology transfer, the remote-sensing progress should be able to steer clear of political controversy.[6]

And each country will benefit scientifically and technologically. The satellites will produce, among many other valuable results, new multicolor images of the Earth's land and ocean surfaces that can be published, displayed on television, and incorporated into a wide variety of scientific, political, and educational materials. In addition, the benefits will be truly global in scope, with third world countries finding the results especially important.

Finally, the project has marvelous public relations potential for the new U.S. administration. The initiative can be taken at the highest level, through a personal invitation from the next president to General Secretary Gorbachev. Indeed, the proposal is made to order for summit diplomacy.

One promising way to implement the remote-sensing program would be to make use of a Soviet space platform in the EOS system already being planned by the United States, Western Europe, and Japan. One of the two platforms to be contributed by the United States could then be declared the counterpart of the Soviet platform.

Utilizing a Soviet platform with an instrument package to be determined by direct U.S.-Soviet negotiations would substantially increase EOS' scientific capabilities. Two basic approaches are possible. Washington could request instruments that are significantly different from those scheduled for the U.S. platform and that exploit Soviet technological strengths. One example is radar. The Soviets have orbited more than forty satellites equipped with radar for Earth observations; the United States has sent aloft only three such craft. The Soviets have also gained extensive radar experience from interplanetary missions. In 1983 two synthetic-aperture radars aboard *Venera* spacecraft in orbit around Venus returned data at a high rate for the better part of a year; the high quality of the resulting surface maps demonstrates Soviet ability to process and analyze such data.

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[6] Jessica T. Mathews, "Global Climate Change: Toward a Greenhouse Policy," *Issues in Science and Technology*, Spring 1987, 57.

Alternatively, the United States could request instruments that are functional duplicates of the U.S. equipment. This approach would enable the satellites to revisit important sites more frequently and create backup systems in the event of instrument failure aboard either spacecraft. Yet the superpowers could choose some combination of these two approaches as well.

Technology leakage is a problem that will dog U.S.-Soviet scientific exchanges as long as the superpower rivalry continues. But Soviet participation in EOS will not diminish U.S. national security. First, each superpower would each orbit its own space platform and retain control over the respective instrument complexes. There will simply be no opportunity for technology transfer. Moreover, if exchanges of instrument packages are approved, appropriate precautions against technology transfer can be incorporated into the agreement.

Second, the scientific information to be returned will have no significant intelligence value. Much of the information--perhaps most of it--will be in the form of radiometric or spectroscopic data, rather than in the form of images. And most of the images that are returned will feature low spatial resolution (e.g., maps of ocean color) or lie outside the optical band. The highest spatial resolution planned for any EOS imaging instrument is thirty meters, yielding scenes far less detailed than those required for photoreconnaissance or even than those currently available commercially from the French or the Soviets themselves. In any case, a limit on spatial resolution could be incorporated into the agreement.

Soviet participation in EOS would also bring access to Soviet territory. This access would permit validation of spacecraft data and permit ground-based, international field experiments to be performed over a much larger land area. And Moscow could secure additional access to the territories of its allies and clients, particularly in the Third

World. Finally, the EOS program could benefit from a broad range of operational Soviet technologies, such as ancillary programs of rocket, balloon, and aircraft observations, together with data processing and distribution. The global study of the Earth requires a set of geographic data centers; establishment of a data center in the USSR would mark a major contribution to this effort.

At present, the Earth Observing System represents a partnership of the United States, Western Europe, Japan, and several other countries. Clearly, all parties would need to be consulted before any approach was made to the Soviet Union. There is little doubt, however, that the scientific communities of all participating states would welcome the major contributions that the Soviets could bring to the EOS program. With the proper groundwork, it is likely that the governments involved would support this proposal, too, particularly as part of a broader campaign to reduce international tensions.

About the Author

Paul Adam Blanchard received his B.A. degree in Physics and Philosophy, summa cum laude, from Yale University in 1960, and an M.A. from Clare College, Cambridge, in 1962. In 1969, he received a Ph.D. in astronomy from Harvard University, where he was a National Science Foundation fellow from 1962 to 1966. Dr. Blanchard also received a Master's Degree in Management from the Massachusetts Institute of Technology's Sloan School of Management in 1982.

From 1969 to 1974, Dr. Blanchard was assistant professor of physics and astronomy at Tufts University, Medford, Massachusetts. He carried out postdoctoral research at NASA's Goddard Space Flight Center in Greenbelt, Maryland from 1974 to 1976. And from 1976 to 1983, he served as special assistant to the director of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. Dr. Blanchard was Senior Scientist with Fairchild Space Company in Germantown, Maryland from 1983 to 1984. He founded Space Research & Management, Inc. in 1985 and currently serves as its president.

Dr. Blanchard specializes in long-range studies of scientific and technical programs, particularly those related to the scientific and commercial uses of space. He is the author of a number of major science-policy studies and articles for a general audience, in addition to earlier scientific research papers, and is a member of the American Astronomical Society, the American Instititue of Aeronautics and Astronautics, the National Space Club, the Washington Space Business Roundtable, and the Harvard Graduate Society Council.

Mr. Nelson. Thank you, Dr. Blanchard. Mr. Rogers.

Mr. Rogers. Mr. Chairman, gentlemen. I am here as the President of the Sophron Foundation. I have provided you with a written statement and so I will speak from some notes here.

I would like to start by making a personal observation. John McLucas and I go back a long way, 40 years ago—if he can remember that far back. We were both in the same laboratory. John said he was happy to be here. Today I am happy to be here, but I've not always been happy to be here. The most recent time that I testified before you was as the director of the OTA study on the space station, a very controversial study, a controversial area, and all of my appearances here have been instructive, useful, but not always happy.

Today I'm here in a happy position because I can inform you of a truly new idea, a space-related idea that has had work done on it for over eight years now, and which is now ripe. The work has been done primarily by individuals. The work has been done quietly in various offices, with some support finally, by the Voice of America, of the National Research Council, and we have in the past two or three months seen some very important governmental movement. But to my knowledge, this is the first important public discussion of the idea. So I'm pleased to be here and tell you about it.

I would like to start off by saying I want to thank Dr. Serfaty and his colleague not here, Bert Edelson, for both prompting me to get my thoughts together on this matter and encouraging me to put them on paper.

Let me start off by recalling immediately to mind a few geometrical matters. The Earth is round. The Earth is solid. Radio waves travel in straight lines. Therefore, if you want to communicate by means of radio waves over great distances, you must do one or the other of two things: you must put a reflector up there so that you can reflect energy to great distances, or you must be up very high yourself.

In the 1920's, scientists discovered that the Earth was surrounded by gases which, when acted upon by solar radiation, became mirrors of certain kinds of radio waves—the ionosphere. We learned that you could communicate via short wave—that is, frequencies which are higher than the broadcast band which you listen to on your radios but lower than FM and television—you could broadcast by sending energy up to the ionosphere, down to the Earth's surface, have it scatter, and go on. That was the beginnings of transoceanic voice communications.

During the Second World War, short wave was very widely used, and subsequent to the Second World War, an increasing number of countries began to conduct what is called today "Public Diplomacy" by means of broadcasting audio programs on short wave. Public diplomacy, in contrast to private government to government diplomacy, finds governments through the creation of libraries or the encouragement of visits back and forth between people by broadcasting programs, trying to get directly to the people in other countries to make them aware of their national interest, their activities, their senses of values, their issues and so on.

By now, we have over 100 countries in the world that broadcast audio programs on short wave. It's not much of a thing in the United States. Not very many people listen to short wave, but I'm sure that any of us who have traveled abroad have had the opportunity of listening to the Voice of America, the British Broadcasting Corporation, Deutsch Wello, Radio Moscow, NHK and so on. These countries have invested some $10 billion in surface plant and spend about a billion dollars a year to conduct this public diplomacy activity nation by nation.

Now, the unfortunate thing about short wave is that, by and large, it's very, very poor. It's a terrible medium for communications. The signals fade, there's a great deal of interference, you can't direct the energy where you want it, the receivers are costly, difficult to use. But to use an expression that is at least as familiar to you as it is to me; something beats nothing every time. And so we have a great deal of activity in international audio broadcasting.

Now, the situation insofar as audio broadcasting and short wave is even made more confused and complicated is because the investment in the plant is great and a new country and a poor country has a very difficult time getting into the game that is run by the United States and the United Kingdom and the Soviet Union.

Naturally, the question has occurred to anybody in the satellite communications business—and I was in that business at the earliest days at MIT—why don't we use satellites? Instead of using the kind of mirror that nature has provided in the ionosphere, why don't we put our transmitters up at great height? We've been doing this ever since Sputnik and so on.

Well, it isn't that simple. If what you want to do is to reach home radios on the kitchen table, behind building walls that attenuate or cause losses in the radio wave propagation, and you want the receivers to be low cost, and you want them to be easily used, then the space segment must deliver what engineers call a big "thwack". It must be an enormous effective radiated power in the signal. And for a long time it didn't appear as though the technology was moving in that direction because today in satellite communications you can make up for the lack of a space segment by putting more sophistication in the surface segment.

But slowly over the years, in about every pi to two pi years, I would take out the back of an envelope and make some calculations, and about 1982 I began talking to the people at the Voice, and that was the beginnings of what I'm going to talk to you about having happened now.

It began then to be clear that the movement in the long haul trunk satellite communications areas began to see more power get up there, some with bigger antennas. And then there was the decision to go ahead with the ACTS Federal program, which has relatively large antennas, large numbers of beams, more power. And I began, and others gradually, began to say well, not today, not tomorrow, but in a few years we can see the practical possibility of having the technology in space that would allow the creation of radios on the ground that people could listen to.

When we got to that point, we began to make analyses. And gradually the Voice of America, with some interest on the part of

NASA, began to support some reviews of this in the National Research Council. The National Research Council has had a committee, two of them now, looking at this, as I say, very, very quietly, for some time. They've published one intermediate report and a working paper, and they're now working on the final report.

The final report essentially speaks to two or three things. One, let me now speak, because I can't for the Council, in personal terms. I am absolutely convinced that we can see within the next four, five, six years very sophisticated satellites, three or four of them up at geostationary altitude. You can have large numbers of beams on these satellites. They have to be very narrow beams because you want the energy sent down of sufficient intensity that these low-cost receivers or radios can be used. You need large numbers of beams because you want to reach large numbers of audiences. So that's where you get your "thwack".

On the ground, we can see digital receivers. We have a large digital computer industry that could easily turn out the kinds of things we need in the radios. And we have something else. We have an institutional idea as well as a technological idea. Let's examine what we came to call the "Ecuador effect"; let us assume that the United States of America agrees it would like to see the Voice of America be able to do this, and it asks its ambassadors to talk to other countries about obtaining agreement with them to have geostationary slots and frequencies. Supposing our ambassador talks to the appropriate man in Ecuador and he tells him that he would like to improve Voice of America transmission. The man would say fine, we listen to the VOA now. That's probably not a bad idea, fine, and we'd like your support for frequencies, your support for geostationary slot. Fine. And when do you think you would be able to start broadcasting to us? Well, maybe five years. Fine. When will we be able to start broadcasting to you?

And so we had an idea, and the idea was to do something never done before in broadcasting, done all the time in long haul trunk, and that is to imagine a common carrier, a common carrier of a Comsat, Intelsat, AT&T variety, to which any country in the world could go and say I'd like to lease a certain number of channels all week long, or on Sunday afternoon, to reach all of the Soviet Union or downtown Sheboygan, and we're willing to pay on an equitable basis for the amount of capacity that we use. That's where we are now so far as the technological and the institutional ideas have come.

Two or three more quick observations. One, if you stand back and assume that this can come about, what we then will have is the practical possibility that every nation in the world can broadcast directly to the people in every other nation in the world, and we can in our homes listen to what the people in Indonesia want us to hear and what the people in Jamaica want to hear, and people in Ecuador can hear what we would like them to hear and so on. And we can't help but believe that at the margin this will increase understanding, a sense of proportion, a sense of balance, throughout the world, at the margin that will be helpful.

The second thing, it will reduce our costs. We'll be able to do this at a small fraction of what we're now paying for short wave. We'll have beautiful signal quality, reliability, and we will have the beginnings of a wholly new business, a business, a space-related business, in which the space segment will cost the order of a billion dollars, and we will have as the market goal the present short wave radio population of the world, which, Mr. Chairman, today is 500 million radios.

Last summer, the National Security Council accepted the views of an ad hoc working committee of the Council and said that this notion, in their judgment, was in the Nation's interest and should be pursued.

This past fall there was a meeting of the World Administrative Radio Council who looked quite favorably and quite positively on the notion, and we now begin to see the practical possibility (a) of this happening, and (b), the United States playing a leading role therein, period.

Therefore, it seems to me that you and your colleagues should become a little better informed upon this—I repeat, this has been going on very, very quietly over a long period of time. This is the first public discussion thereof—and secondly, that you could think out ways by which, at the margin, the Government could play a useful, cooperative role.

Now, let me pull apart for 30 seconds. I have been in the space business all of my life, but I'm in other businesses as well. I'm in the housing business and I'm in the health service delivery business. And it is a continuing sense of frustration that I have when I hear things such as I hear in this room today, and I feel so sad about the things going on in the civil space area and are being talked about going on, that I would emphasize here in this one specific regard that the Government really can't do very much, and shouldn't do very much, but it can do some things. The reason is that the private sector should march out on this.

These should be private moneys that are used here. The Government has already done what the Government can do to an excellent first approximation, and that's develop the basic technology in the ACTS program for other reasons. It can go beyond this and do more to be of help to the radio astronomers and the deep space probe people and the space radar people. But the industry now, our industry, should be doing what should come natural to them, in looking at that technology that's been developed and begin to think seriously of starting new businesses.

Now, the Government can do a little bit of the following: one, the United States Information Agency and the VOA could have their leadership get up there on the bully pulpit and say national interests would be served if we marched out on this. Our space industry should take a look at this and position themselves to get on with the design, development and acquisition and placement of the space segment. The Department of Commerce should be pinged on, not only in the NTIA, which are doing what they should do right now, but to think in terms of this enormous potential market for radios. We're talking about tens of billions of dollars worth of business here, and as you know, if you read in the newspapers about the high definition television business, we're faced in this country of having essentially given up the consumer electronics market, which is a very, very sad thing. So there's a possibility there. I would conclude by making the following observation in the context of Dr. Serfaty being here and how these studies came about.

If there is anything that the Soviet Union and the United States could cooperate on to our each independent benefits, and to the benefit of the world, it would be to see space used in this particularly beneficial way, to improve the ability of the governments of the world to express themselves to the peoples of the world, and the peoples of the world to be able to get independent sources of information on anything and everything that interests them.

We've heard about Mars. I won't say anything about Mars. But I will say that, of all the things this country could do, it strikes me that this is at least as important as reaching out with the Soviet Union to the Planet Mars.

Thank you very much.

[The prepared statement of Mr. Rogers follows:]

USING SPACE BROADCASTING TO PROMOTE INTERNATIONAL UNDERSTANDING

T. F. Rogers

President

The SOPHRON FOUNDATION

McLean, Virginia

Submitted as part of the testimony of T. F. Rogers before the Subcommittee on Space Science and Applications of the Committee on Science, Space, and Technology of the House of Representatives, the U.S.Congress.

February 9,1989.

One of the ways that some 100 governments now pursue their important "Public Diplomacy" interests is by broadcasting radio programs on shortwave to much of the world's population _via_ such organizations as our Voice of America, the U.K.'s B.B.C., Radio Moscow, Radio Netherlands International, the F.R.G.'s Deutsche Welle, ... The global shortwave listening audience has been estimated to be in the many 100's of millions.

In doing so, many of them employ very large, powerful, multi-frequency, and costly surface-based transmitters, and the Earth's ionosphere and surface, to propagate their signals over great distances beyond their borders. But shortwave broadcasting oftentimes lacks the coverage, reliability, and quality to retain listening audience attention, and most shortwave receivers are either not easy for many to operate or are too highly priced for many to purchase. And the listening audience continues to be offered an increasing variety of alternative listening, viewing, and reading options. As a consequence, relatively few in the United States and too few elsewhere now take the opportunity to learn about the views, interests, and activities of other countries of the world _via_ shortwave radio.

Too, many newer, lesser developed, nations are not able to match the frequency assignments and/or capital investments of the earlier, better positioned, shortwave broadcasters, and they find that they cannot balance the programs delivered to them by broadcasting effective programs of their own.

Fortunately, the past several years have seen the development of space and communications technology, and related broadcasting operating concepts, that now suggest, strongly, that powerful and sophisticated ultra high frequency (U.H.F.) orbiting transmitters could be used to replace, over time, the world's surface-based, individual country, shortwave methods and means. Space transmitters, located in geostationary orbit, could be part of a global common-carrier (common-user) D.B.S.-A. (direct broadcasting by satellite-audio) system-service that would provide equitable access to all of the world's broadcasting governments -- a service of unexceptionable performance. Listening to radio programs provided by such a service then would be as easy, inexpensive, and direct as listening to local over-the-air A.M. and F.M. radio programs is today. And the world's government broadcasters then would have available to them a superior, indeed quite competitive, world-wide radio broadcasting service which they could lease to meet their needs at a fraction of their current shortwave costs.

While important satellite technology needs to be developed (and the private sector-Government A.C.T.S. program should see important strides made toward developing the basic kind of technology needed) frequency band allocations made, transmission standards set, one or more system acquisition and operating groups established, etc., etc., in principle a D.B.S.-A. common-carrier, common-user service could begin to be offered well before the end of the next decade. A Committee of the National Research Council, supported by the Voice of America, has been studying DBS-A for the past few years and has stated, in an interim report, that the Country should be alerted to "... the opportunities for the future that it presents."

Last summer a Working Group of the National Security Council concluded that "Direct broadcasting of sound programs from satellites ... can overcome ... deficiencies [in today's shortwave] broadcast signal, broadcast area coverage and cost per broadcast program hour. ... [D]irect broadcasting of sound programs will provide [us with] an opportunity, worldwide, to meet [our] public diplomacy objective... ." And the N.S.C. itself formally agreed that "The statement of strategic objectives in the August 1988 Working Group to the NSC accurately reflects U.S. objectives." Too, last year's World Radio Administrative Conference (W.A.R.C) came to encouraging conclusions re the future of DBS-A.

The United States should encourage and support the world's acquisition of such a D.B.S.-A. system-service, and there are several early steps that it could take to do so.

Some of these steps could involve the Soviet Union. Former President Reagan and General Secretary Gorbachev are on public record, oftentimes, as favoring better communications between their peoples and among all the peoples of the world, and of seeking cooperative ways to improve international communications. Too, both countries particularly favor the conduct of cooperative civil space activities. And, within the past two years, the Soviet Union has stopped jamming the B.B.C. and the V.O.A.

In reporting publicly on the Reykjavik summit meeting in late 1986, General Secretary Gorbachev said that he had expressed chagrin to (the then) President Reagan about the ability of the United States to broadcast to his country in widespread fashion while, because of shortwave propagation characteristics, shortwave receiver populations, and the two countries' geopolitical circumstances, the Soviet Union is unable to broadcast effectively to the United States. President Reagan is reported by the General Secretary to have said that he would think about this matter when the Secretary brought it to his attention but, to date, the U.S.A. has not been able to find a solution to this problem of communications imbalance.

These circumstances provide a specific opportunity for the U.S.A. and the U.S.S.R. to use their space and communications capabilities to serve their individual interests -- they could cooperate with each other to see a new world-wide space-based audio broadcasting capability come into existence. Further, they could solicit the cooperation of all of the other countries of the world to see space put to this particularly useful purpose "for the benefit of all mankind". Were they to cooperate in this fashion, the process by which such a broadcasting system-service could come into global use would be eased and speeded.

Therefore, the U.S.A. should seek to arrive at a bilateral agreement with the Soviet Union to create a D.B.S.-A. system-service, and to initiate certain early cooperative measures that would set both countries on the path of so doing. One such interim measure could see commercial satellite communications services employed to allow Radio Moscow programs to be made available, widely and easily, to listening audiences in the U.S., while V.O.A. programs were similarly conveyed to listening audiences throughout the Soviet Union. Elements of the existing radio and/or television networks in each country would be used for local over-the-air rebroadcasting of the audio programs late at night.

At the same time, though, given the Soviet Union's particularly dynamic internal political situation today, and the difficulties that probably will continue to affect U.S.A.- U.S.S.R. relations, the U.S.A. should make plans that would allow it and other countries to proceed, satisfactorily, with the acquisition of a world-wide system-service should this agreement either not be reached or ever lapse. And we should not provide the U.S.S.R. with technology that would improve the latter's military capability.

Considering the wholly new market that would be opened up for large and sophisticated communications satellites, their launch to orbit, their surface program feeders, the several hundred million new radios needed, and the operation of the broadcasting system-service, a new space-related commercial-industrial business would be created, and private capital could be, and should be, used to do so. The initial magnitude of this business could be many $ billions (U.S.A. 1989 dollars), with annual sales and revenues of hundreds of millions of dollars/year thereafter. Too, it seems reasonable to expect that such a system-service could also be used by many countries for domestic broadcasting. And other than government broadcasters also might be prompted to use the service. Eventually, technological advances in the effective radiated power of orbiting transmitters, and in sophisticated digital signalling techniques, could allow television as well as audio broadcasting by the system. Indeed, in the longer term such advances could impact all local over-the-air broadcasting and cable distribution systems.

However, in order to conduct a D.B.S.-A. activity successfully in economic as well as political terms, the U.S.A. will have to resolve some long-standing Government-private sector difficulties in the development of costly commercial space-related technology. Doing so could be important to our future space and communications business prospects, so that these difficulties should be addressed with imagination and resolve. Insofar as the space segment is concerned, here would be an opportunity for the Federal R&D community, in concert with related private sector interests, to bring together common, longer range, interests in radio astronomy, deep space probes, planetary exploration, ballistic missile defense, air traffic control, and weather reporting, and interest in the use of an orbiting Space Station to assemble and check out large and precise transmitter antennas. All of these space-related areas should share a common interest in seeing very large, powerful, and sophisticated space technology developed. In time, this technology could allow new space science and exploration missions to be considered with greater confidence, new space-related services to be offered, and new private sector businesses to be created. Doing so would hasten the day by which DBS-A would become a widespread operating and economic reality.

When contemplating ways in which the world's powers could marshall their common public diplomacy interests, and their communications and space capabilities, cooperating with each other to improve international radio broadcasting should rank high in importance and urgency. And, especially for the two super-powers, the potential value of cooperating to use space to improve international communications should rank at least as high as undertaking a cooperative program to travel to Mars.

(For a detailed exposition of this subject, in addition to The Johns Hopkins University, Foreign Policy Institute, School of Advanced International Studies publications, the following [unpublished] paper should be referred to: "Using Satellite Direct Audio Broadcasting To Conduct Public Diplomacy", by T. F. Rogers: October 12, 1988; 71 pp. Its preparation was supported by The SOPHRON FOUNDATION, McLean, Virginia.)

Mr. NELSON. This is an exciting time, and technology has brought us to this point, with which we could contemplate this kind of exciting communication exchange, indeed. Members of the committee, comments or questions? Mr. Tanner.

Mr. TANNER. Thank you, Mr. Chairman. I appreciate that.

I'm new to the Congress, certainly new to this committee, and if I ask a question that is untoward or stupid, please forgive me—and I apologize that I was not here yesterday.

All of the testimony that I've heard this morning, there seems to be a common thread, and that is a lack of coordination, perhaps for the lack of a better word, among the structures that we have in place now in governments and so forth.

My question is, a year or so ago I read or heard about a UN-commissioned committee to study global warming and some of the concerns that the environment has for us all, and I haven't heard the UN mentioned here. Is the UN, in you all's collective opinion, or individual opinions, so politicized that it is incapable of being useful as we struggle to put in place some sort of institutionalized or structural approach to cooperation among the nations, particular the United States and USSR? Is that a dumb question?

Mr. ROGERS. You do have the advantage that John McLucas and John Logsdon, who appeared earlier, they have looked at this hard. I think they said some things for the record earlier this morning.

In the case of communications, there are international groups, the international telecommunications, and I think in terms of public programs, it's sometimes mandatory that you have a UN or international bodies working. But I must say that in my particular view, the best way to coordinate is to get out front and coordinate backwards, not arrogately and not imprudently, but—and in the case of communications, that's mandatory.

Dr. BLANCHARD. Mr. Tanner, if I could comment, I think your question is quite reasonable, because after all, the UN was formed over 40 years ago to perform exactly this kind of service in many respects. They do have as vigorous interest in the environment. The United Nations environment program is quite active. They have a companion program called GRID, the Global Resource Information Database, which is building up means for analyzing data on the Earth. So the UN is active.

My own personal feeling is that one problem is the United Nations has never been given real power. It's a coordinating body. After all, the money is contributed by the member nations, and the United States has not always been the first to pay its share, I may point out. We've had some problems with the UN as a political forum. My feeling is that to get something really done in this area, I think it's critically important to do that. It will be up to bilateral and multilateral agreements among the nation that are perceived in their best interests that can go right to the highest levels, and the United Nations would be a very good forum for the dissemination of data to other nations for auxiliary programs.

But I think if we want to get out front on the study of the Earth, as I think we must do, we have to take that initiative ourselves. I believe if we want to cooperate with the Soviet Union, we should approach them directly.

Dr. SEIELSTAD. I would only comment that in the specific project that I mentioned, I don't think the United Nations is the appropriate body to carry this out in.

I want to add my personal sentiment, that it's an outstanding organization and needs all the support it can get. It just doesn't apply to the thing I was talking about.

Mr. NAGLE. (Presiding.) One of the things that's impressed me since I came on the committee—and I'm Dave Nagle from Iowa—is there seems almost to be a schism between the scientific community and NASA over the direction of the program, the scientific community feeling that NASA should move in certain directions, NASA apparently following the administration's dictates and moving in others. It concerns me as a Member of Congress when the entire scientific community is screaming that we're going the wrong way, and yet we've gone for eight years, we've gone the other way.

Is there any prospect of a reconciliation taking place between these two parties, or is it going to take a fundamental change in NASA's direction?

Mr. ROGERS. No, there is no possibility of reconciliation, but not for the reason ever discussed in these halls—

Mr. NAGLE. Divorce granted. Next.

[Laughter.]

Mr. ROGERS. This gives me a 30-second opportunity to make one of the most fundamental observations that can be said about the civil space area, Mr. Chairman.

It costs too much. We're not arguing here about turf or whether science is better than technology, or technology is better than housing. When you're talking about the civil space area, you're talking about an area that has attracted some of the brightest people, the most energetic, the most imaginative people. But to do anything, they're faced with costs that are so enormous, so enormous, that very, very little can be done.

You know, this country has spent $500 billion in "cash out" in publicly supported civil space activities. If you put in the cost of money, it's probably a trillion dollars. We're spending $10 billion a year and not very much goes on up there. Very little goes on. And the reason is cost. So when you have the scientists and the technologists and the men in space, it's because everything costs so much. But since nobody much cares, it will continue to cost so much so we will never have very much going on and this battle will continue indefinitely. I never hear it discussed ever—

Mr. NAGLE. Is it strictly a matter of cost? Is it strictly a matter of there's not enough money to go around, that's the only problem?

Mr. ROGERS. Oh, certainly. Look, Mr. Chairman, if I wanted to put my shoes into orbit, my wife would say, if you have to pay for it, we'll have to defer a three-month, first class, around the world vacation. If I turn on a 100 watt bulb and keep it lit for a year, the bill is $100,000. If I have a 10 by 10 by 10 office in space, and I use the space station cost for habitable volume, I will have to pay a million dollars for that office. A million dollars a day.

Mr. NAGLE. I think what the scientific community is saying, though—and I don't want to get you, doctor, into this—but I think they're saying our priorities are wrong, aren't they? I mean, everybody recognizes the limits are finite. I mean, you know, we don't have an unlimited amount of money, but doesn't the schism read—

Mr. **Rogers**. No. It's a somewhat different thing, Mr. Chairman. What we have are people not driving down the unit costs. We don't have people in the civil space area charged or encouraged to drive down the cost.

Dr. **Seielstad**. Mr. Chairman, despite the fact we're in the same study, I think we're a collection of individuals who actually didn't meet before today. I would say the scientific community is not ready to say NASA is incapable of work—you know, will find it impossible to work with them. There is some confusion about their mission. Is NASA's goal heavily loaded towards commercial applications, as Mr. Rogers is leaning? Is it a national prestige, a symbol of national prestige, where, you know, the White House and Congress want to do things for their appeal to the public, or is it a scientific organization trying to increase our understanding of the universe?

I think one of the problems is it has all three of those functions and, therefore, you never quite know where to plug in. I think that also means, when you're trying to plug in, you find the apparatus very cumbersome. I guess the project I described was more one that it's just going ahead. I mean, it is happening. We're not asking for a lot of money. But somehow the mechanism is preventing us from taking part in it, and alone among nations which have a lot less money to spend on it than we do.

So there are hopeful signs. NASA is traveling to the Soviet Union next month in a delegation to discuss this specific project. They have brought someone to headquarters from JPL to worry about orbiting VLBI's, so I'm in an awkward moment criticizing them just when I think they're about to do the right thing. But I would rather be here after they've done it than hoping that they're about to.

Mr. **Nagle**. Dr. Blanchard?

Dr. **Blanchard**. Mr. Nagle, I think you put your finger on a very characteristic issue for NASA, one that has been characteristic for the duration of the shuttle program and now moving into the space station era. I don't think this is any misperception at all. There is a division of opinion at NASA and surrounding the NASA program in the scientific community.

Let me just comment on it this way. I think that one—I have no solution to the problem. I think it's real. But I think it goes back to the fundamental questions of why we have a space program. It comes back to some of the issues that have been talked about here today, about the possible role of the Space Council, national goals and so on.

The space program has been one of the most effective scientific tools in history. Simply getting above the atmosphere to look at the universe, astronomy, astrophysics alone, planetary exploration, now having the chance to look down at the Earth from space, and to have a global rapid view that we've not been able to have before, these are incredible achievements. You've read more has been learned about the Planets Mars and Neptune and Jupiter through the space program than was learned in all of previous history and so on. Space has given us a tremendous window on the universe and a new view of the Earth.

But the conventional wisdom in this town, to the extent that I've been able to find it out, is that, in fact, the American people would not support the space program if it were not for human beings in space. This is what the American people really identify with. They identify with astronauts, they appeal to our young people as a vision of possibly becoming an astronaut in the future, and this has a human interest element, a political element, that scientific research, however valuable it is, simply cannot match in terms of public appeal and public support.

I believe what has been driving NASA policy is the assumption that we must maintain a vigorous manned program, not only for the scientific opportunities it may collaterally present, but simply because this is what the American people expect in a space program. They want the flag on the Moon, they want the television transmission from orbit, and this is what they're willing to pay for.

The manned program, obviously, has different objectives. Many of them are political or human interest. The cost is ten times what it is for an unmanned mission, just to keep human beings safe and alive in orbit. This is the dichotomy we face. I think most people who have looked into this realize the tremendous benefits and advantages and appeal of both sides of that house, but it is two sides of the house and we don't have a unified voice yet, in my opinion. And if one thing the Congress and the Space Council could help us get would be a unified voice, I think we would all be much better off.

Mr. NAGLE. Do you think, Dr. Blanchard, if I could follow up and stay with the same generic question, do you think the house is loaded too much on one side, on the manned side?

Dr. BLANCHARD. You're asking me to get into difficult territory here. Certainly the claim has been made—let me put it that way—that the support of manned programs has come at the expense of science, and the most vigorous and articulate proponent of that view is Dr. Jim Van Allen. I'm sure you've heard from him.

The threat always exists—

Mr. NAGLE. Weekly.

Dr. BLANCHARD. —simply because of the sizes of these manned programs, that in any cost overrun or cost growth development, science programs will be killed. And he's written articles about this. I don't need to go over that.

I think most people think we need both kinds of programs. It's just that when the budget crunch hits, as we all expect it will, every year, and increasingly, what gets left in and what gets taken out. It's the lack of a clear mechanism for making those trades that I think concerns a lot of people.

I think you will find people on both sides of this argument who are very persuasive. I don't know how I would come down on that. I'm trained as a scientist, so I think I'm a little biased. But put it this way. We have no clear mechanism, no clear set of decision rules, no clear leadership, that enables us to make those decisions.

Mr. NAGLE. Dr. Serfaty, do you wish to—

Dr. SERFATY. No, this is a bit out of my field, Mr. Chairman. This, in a sense, points to another schism, which is the schism between policy and technology. Those among us who analyze policy and do not understand very often the technology related to those policies we assess find it increasingly difficult to come to proper conclusions. For example, 20 years ago you could easily be a defense analyst without a clear understanding of some of the weapon systems involved in your assessment of policy. This is no longer the case.

I think that this schism, too, deserves some attention which we, for example, at the Foreign Policy Institute and at the School of Advanced International Studies, both of which are related to the Johns Hopkins University, are attempting to cope with. How do you make students and professionals aware and cognizant of some of the items which they need to know—how they work and how they might develop in the future—in order to be able to cope with respective subject matters. So the schism is not only among scientists but between scientists and outsiders as well.

Mr. **Nagle**. But the community itself, the scientific community itself, is pretty—I don't want to say unanimous—but close to unanimity on the fact that we are not putting enough emphasis on the sciences. You can disagree on which scientific project we ought to be doing, but I think the scientific community, for the last ten years, has been screaming that we're not doing enough science, period, and too much manned, at too great a risk. Would that be a fair summation?

Dr. **Serfaty**. Yes.

Dr. **Blanchard**. That's certainly a fair summation of the view of the scientific community, yes.

Mr. **Rogers**. But again, Mr. Chairman, I would observe we ought to know why this is. We've got to get down one more level and simply observe and appreciate that the reason is that things cost so very much. And we are not going to get out of that by calling for greater leadership or a National Space Council or more sharply defined programs, or trying to decide—We have not done in space what is done in every other area, to my knowledge, in this country. And that is to focus on economic issues and drive down costs. Now, I'm not speaking as a businessman. I would say the same thing about going to Mars or going to the Moon.

Let me say something to try to be helpful to you about thinking about what the country might be doing in space with respect to people. I have a good relationship with a former cabinet officer, and I met with him some six months ago for a breakfast. When we were finished, he said, well, what else are you doing, Tom? I told him about being in space. He said, what are you doing that for? And I said, because it's very interesting. He said, but, you know, it's really not important. It's not the sort of thing that— I said, well, you know, you're not correct. He said, how is it that I'm not correct, and I said I know of polls that have been taken in this country, only three of four of them—and they're not the kind of polls that you hear publicized about the space business. It's a very specific question that was asked in three or four proposals. It said not what should the country be doing, what should NASA be doing, how much money should be spent, is it a good thing. The question was what do you want to do about space. And the answer is, in those three polls, one of which was conducted after the Challenger disaster, and a replicate of it in the United Kingdom, the answer was that 40 to 45 percent of the adult population says: "I want to take a trip to space".

This cabinet officer said to me then, well, what is the Government doing to help the people to do that, and the answer is nothing, nothing. Of course, I suppose the answer is because it costs too much or people don't understand this.

Mr. NAGLE. Let me put the cost right here on the shelf for a minute. Let me pursue one other concern that I have that has been voiced by Dr. Van Allen, been voiced by Dr. Gernet, Lou Franks, people at the—my university, and that is—we can talk about scientific projects, but is there a way around the current dilemma you have that if you sign on to a scientific project in 1975, you might not see it fly until 1995 and in 1994, you might be told it's going to be postponed again.

I mean, you know, it seems to me that we've gone into a tremendous lag here between marrying people to programs and then the programs are perpetually postponed. I can think of innumerable examples of that.

Dr. SEIELSTAD. I think this is a problem. I think it would help the system entirely if decisions—even no decisions were made. It is the case that you can get involved in a project and it is so long before you actually get any data or get any of the returns that you've been working for that you've almost forgotten why you were interested in it in the first place.

It would help if things happened faster. In this particular RADIOASTRON project, it's just marching ahead and yet, we don't have a firm yes from the administration; we don't have a firm no as far as participation goes, but eventually it'll happen and we'll have been part of or we won't have been part and you—you would think in something like this, you would—you would either have your definitive yes or your definitive no by this time.

So there must be a mechanism where suggestions are made and they get reactions. And the reaction isn't, we'll just continue to discuss this, because it—it is having a negative effect.

As far as science goes, there's something awkward happening since this project we're involved in I would not identify with the Soviet Union. They have invited many nations and many nations are participating, but for years, the strength of science in this country was the vigorous free exchange of ideas. We championed the idea that you put your stuff, published it in open journals, you had arguments with your colleagues and, out of this process some way, the truth emerges.

The Soviet Union's science was held back for a long time because they censored their scientists. They couldn't travel to every international meeting. They couldn't read western journals. They couldn't talk to their colleagues.

Suddenly, there's a reversal taking place and it's very ugly for the scientists in this country. Russia's thrown the door open, invited people to participate on any level that you wish. We'll exchange data with you; we'll allow you to do whatever you want.

We're wondering if we can. Can we send this gadget or not? Can we talk to our colleagues and this is an extraordinary turnaround that I think has only ugly implications. If the rest of the world is participating in a project and we're refusing to, and where cost is not the argument, it's symbolic to the rest of the world about how we're proceeding.

Mr. **Nagle**. Dr. Blanchard.

Dr. **Blanchard**. I'd like to echo your concern about the length of time it takes to get space science missions off the ground. I participated in a study of the future of the astronomy and astrophysics for the 1980s. Our report was completed in 1980, published in 1982. The Advanced X-ray Astrophysics Facility, for example, which was the top recommendation of that study among major space projects, was already well designed and planned in 1980 and is only now being started by NASA in 1989, and it will be many years before it flies.

So we're talking about 15 or 20 years, start to finish, on some of these things. By that time, entire generations of graduate students have passed through universities and the instruments are not of the—not as up to date as they might be because they've been put to bed years before. This is a real issue.

I'd like to mention one more thing, though, about NASA, since we're talking about some basic structural problems and I certainly think that Tom Rogers' comment about the money is an apt one. We're not being driven by any force to look for a cheap way of doing things in space, the way business must be. And I think this is a good concern.

I'd also like to contrast NASA with most other Federal agencies. Let's take the Department of State. It's never going to go out of business. It's mandated by the Constitution and it's going to get its cut of the national budget because we know we'll always need a Department of State. Same thing, Department of Agriculture. We're never going to get rid of that. It's always going to perform a service because we've always got to eat.

NASA's one of the few agencies that conceivably could actually go out of business. It could actually go out of business. There's nothing in the Constitution keeping it alive. It depends on perceptions. It depends on leadership.

Since the moon shot, it's also depended for its existence on some major project. In other words, instead of—instead of saying we're going to have a space program and giving NASA and our agencies the freedom to choose what missions would best be carried out within that envelope, what we've got, in my opinion, is the situation where NASA staggers on from one decade to the next with its existence only determined by its approval of that particular project it's going to undertake.

First it was the moon shot; then it was the Shuttle; now it's the Space Station. We have not yet got to the point in this country where we're willing to peel off a certain fraction of the GNP and say we're going to do space with this fraction, and now let me look within that fraction and see what I want to do.

So I think we've got the cart before the horse, and this overwhelming need to justify a mission, I think, can distort the best mix, and it may be keeping us from having the optimum mix of science and manned missions in our program.

Mr. **Nagle**. I think that's very perspicacious. I think the agency has had a propensity to come to the Congress for funding because it's, you know, the shuttle, the reusable shuttle—it's the Apollo program; it's the Mercury program. You know, there's always some great goal out there. Now it's the station.

How much has the lack of an unmanned—unmanned launch system capability, do you think, contributed to the schism that we're developing or we've developed between the scientific community and the agency?

Dr. **Blanchard**. Very substantially and I think most people, even in the manned program, would now admit that that was a fundamental mistake. Of course, that's hindsight. It's easy to look back now after the Challenger accident and the problems we face in the delay of space science missions and the fact the shuttle never has lived up to its original cost, advertising and so forth. Easy to look back and say it was a mistake, but now we—that we can look back, I think we have to say it was a mistake and that the military and NASA should make all possible speed in giving us a stable of reusable—expendable rockets, which is the way the Air Force has been moving now for some years, and NASA reluctantly moving in that direction. This is a very good development.

Mr. **Nagle**. What—tell me why, because this committee, under the leadership of Chairman Nelson two years ago, pushed very, very hard and with the cooperation of Chairman Roe, pushed very, very hard to—for NASA to develop the ELV capability. As a matter of fact, we put money into the budget that they refused to spend. We authorized something like a hundred million dollars for ELV developments; they only spent 25 of it, and that reluctantly.

What—if you know—or what is your perception—what's the reason for NASA's reluctance to develop the ELV capabilities that everyone else seems to agree that they need?

Dr. **Blanchard**. I'd like to toss that to Tom Rogers.

Mr. **Rogers**. I don't know, Mr. Chairman, I haven't thought about that. I just don't know.

Mr. **Nagle**. Well, if you think of it, let—

Mr. **Rogers**. I think a few years ago, it was very clear that NASA had put all of its chips on the shuttle fleet in its development and operations, but I don't know what the reasons are today. I haven't looked at it.

I could say one thing, though, about your more fundamental question, and that is why do things take so long, why they cost so much and so on. There is something going on now in the outside world and some of the people have spoken for very short periods of time to this committee, the Space Phoenix program, and John McLucas and I are involved in that—I'm not here today to talk about that, but there is—there are some things that do offer some promise.

Mr. **Nagle**. Mr. Rogers, then, let me move your cost equation back off and ask you a question that the committee would like to know.

Clearly, one of the goals of—one of the purposes and one of the opportunities—one of the opportunities of international cooperation would be you would share costs. The general question we want to ask you is how do you balance the political, social and scientific advantages of joint scientific ventures with the potential disadvantages of a loss of scientific leadership and military advantage, looking particularly at the Soviet Union, but other areas as well? How do you strike that accord in there?

Mr. **Rogers**. Well, I'll give you an elliptic response in this fashion. First of all, I was Deputy Director of Defense Research and Engineering for four years and I want to be very, very thoughtful about our national response—NASA security responsibilities and interests.

I lectured at the International Space University this past summer, and at my particular lecture, in the front row, there were a half dozen people from the Soviet Union in the front row and on the other side were a half dozen people from the People's Republic of China. We talked about a number of things, and finally we got down to talking about costs and I asked, from the platform, what was the Soviet Union really spending on space, and the People's Republic of China, and they caucused among themselves and said, well, they really didn't know.

And I said, are you telling me the truth? Is it—did you know and you're not allowed to say or is it that you really don't know? They said, well, we just never think about it. I mean, that's—that's not our interest or our concern, and so I said two things, you've learned not from the United States, God help you, and two, wait until your people find out what you're spending on space and then you'll find out and now we see that the Soviet Union apparently is running an annual budget deficit that puts ours to shame. Their annual deficit, I think, is running now 20 percent of the budget and ours is down around, you know, a fraction of that, and we're on the rack.

These things are beginning to sort themselves out now, Mr. Chairman. We're finding out that—we're finding out two things with respect to space business. One, it costs so very much that we have got to find ways of cost-sharing. And the second thing is that many of the things that could go on in space—and you're hearing about three of them today—a combination of interests in the radio astronomy field, the combination of interests in the remote sensing field, the combination of interests in the communications field that just inherently bring the countries together. That should be fostered.

And if you do, you will spread the costs and gradually the costs will come down and more could go on.

Mr. **Nagle**. Anybody else want to comment on that?

Dr. **Seielstad**. Only that as far as the cost equation goes, if you succeed at this bringing the peoples of the world together, it should relieve a lot of costs in the national security area. It's not a—you can't justify every activity that creative human beings do on some sort of bottom-line reasoning that says there has to be a marketplace product—what was the profit? Sometimes there are intangibles since human beings are involved that make a better world to live in, and that's worth a hell of a lot of soap suds.

Dr. **Blanchard**. Mr. Nagle, could I just make a final comment? You asked if I could think of any reason why NASA would turn down money to build ELVs. I ducked that question—I'm still going to duck it a little bit, but I say—I would say this, that if you were to try to answer that question, I think you would come down ultimately to NASA fears for its survival as an agency. I think that's what's basically at the bottom of this; that is, the future of the manned program. I think there's a very large constituency in NASA that see the future of the manned program as the key to their survival, their functioning and their contribution to the nation as an agency.

And anything that threatens that program is of great concern to people who have that fear. I think the best way of approaching that entire problem is to try to establish a more secure base for NASA funding and program that's within the national economy, rather than just a mission-by-mission or program-by-program basis. Really, it amounts to a decade review, Apollo, shuttle, space station. These are roughly 10-year programs with very large funding envelopes and as soon as NASA finishes one, they go on to another.

I would like to see the justification for a space program within this country, independent of which particular project they took on, but rather a mandate to do something in the national interest, and have that decided on other grounds. And I think until we can move to a situation like that, we're going to have fundamental fears within NASA for its survival and effectiveness as an organization. That will be driving many of these political decisions.

Mr. NAGLE. Thank you, thank you for the good answers. Mr. Perkins.

Mr. PERKINS. Thank you very much. I'm sorry, we have three hearings that I've been going to this morning and I haven't had time to read through your testimony.

I am interested in this topic and I suppose one of the things that really has interested me in the past has always been the concept of manned flight and has always been a concept, ultimately, of colonization in space. That is one of the driving things that I have always centered on in my interest in this particular area. In terms of an overall goal, what do you think are the necessary steps to take to ultimately arrive at that particular place? Anybody? Go ahead.

Mr. ROGERS. Thank you for asking. I would suggest that this country should articulate and in the political domain obtain the consensus for the adoption of three goals, and the chairman, Mr. Nelson's letter did say that we should speak to this, but one, that the United States commit itself to the spreading of human life throughout the solar system; two, that it commit itself to opening up space to the general public; and three, that it commit itself to deriving whatever political, economic and cultural value it can from the first two activities.

I would go on beyond that and say—and I think Paul has hit it right on the head—I would divide the responsibilities or see, rather, that the division of responsibilities be that the government will take the responsibility of spreading life, seeing that life is spread throughout the solar system because there is no business to be done there. The risks are enormous. All the technology has to be new—that the private sector take the responsibility for opening up space to the general public, out to LEO and so on, get those costs down and get beyond the point where people think vicariously of being in space and actually being in space.

The minute that you have people such as you have here today in the form of Dr. Seielstad and Paul, John McLucas, thinking about how do we derive economic and political and social benefit out of all of this, that would be my suggestion to you.

Mr. **Perkins**. Well, that's an interesting thought. I wonder, you know, when you look and see again some of the reports—the Rogers Commission, for example, and you look and you see some of the layouts and the long-range plans that are presented there, and—I wonder if almost we haven't taken steps backward over the last 20-plus years in our space program, certainly since landing on the moon?

It seems like if we don't have some sort of goal constantly to drive us forward, we seem to flounder. We seem to lose purpose. At least that's been the way I've looked at this. It seems to me that we have always, as you say, some short-term type of goals that tend to power—I think Dr. Blanchard was indicating that earlier—the programs over a short period of time.

But at least it seems to me that if we're going to really get a comfort factor, as Sally Ride once described it to me, with space and being in space, then we've got to be there, and certainly something like the space station, then—let's say activities on working with a variety of substances on the moon to see what technological manufacturing we can do there, are initial ways of gaining this comfort factor with outer space and with then going towards an ultimate type of goal of actually seeing the transplantation of the human species into other realms.

Do you have any type of thinking along these lines? Should it be a gradual type of access or should it rather be something that is done with a specific goal in mind?

Dr. **Blanchard**. I'd like to comment briefly on that because I think the Congress and the Executive both need to look closely at whether a goal, such as Mars, can really be constructed by analogy with the goal of the moon landing.

Mr. **Perkins**. There's a lot of question about that. Some people say forget the moon, go to Mars directly.

Dr. **Blanchard**. Well, whether or not you want to go back to the moon—and I just talked with Harlan Smith from Texas and he's got a whole package of scientific ideas about how we can use the back side of the moon for an astronomical observatory and I'm sure it's all great stuff. On the other hand, people say, well, we've been to the moon. That's boring; it's over, right.

What I'm saying, though, is that the idea of getting in a rocket and going someplace as a goal, I think has been in our mind since the Apollo moon landing. In other words, that was the idea, to place a man on the moon and return him safely to the Earth.

It was great for 1961. That's just what we needed. The question is, is that kind of a goal great for 1991 or 2031? I don't know. Let me give you one possible alternative, and that is simply to construct—this is less glamorous, less visionary, perhaps, but it may be just as important—to construct a system or series of systems in orbit around the Earth that will serve as a basis for all future space operations.

We're going to have to do that anyway, whether you call it a goal or not. It will form the basis for expeditions to the moon; it will form a staging area for missions to Mars; it will form the infrastructure for any commercial operations in space; it can be expanded to include Earth-observing systems. In other words, to move out into space and to build the infrastructure that we will need.

This gets also to the cost element, by the way, because if you were to do that, you would come up against how much it costs and whether or not any of these things is economic.

Something like that tends to take a back seat, necessary as it is, to a goal that has a distant place in mind and a flag planted someplace and a two-year round trip. Nevertheless, I think in practical terms, in terms of NASA's planning and congressional support, we need to think about what capabilities we will be assembling in low Earth orbit, because they will probably form the basis for whatever we do in space in the next century.

And I'm concerned that we're skipping over that intermediate necessary step, that infrastructure, just like the national highway system, just like gas stations, which is the only reason you can drive any place because you're confident you've got to have a road and you'll be able to buy gas.

We don't have that in space yet. And I think we'll be handicapped until we do. So I hope we can rethink our idea of a goal in the program, taking that necessary infrastructure step into mind.

Mr. PERKINS. Don't you see, then, the space station as being that next step?

Dr. BLANCHARD. It is that kind of thing—you can argue about the particular qualities of the space station, but the idea—in fact, one of the original—the original ideas of the station was as a staging ground. That's sort of been lost. But the idea of building up a capability in low Earth orbit under any name certainly is something we need to do, I believe.

Mr. PERKINS. Thank you, Mr. Chairman.

Mr. NAGLE. I want to thank you for your time today. I want to thank you for your thoughts. They've been very valuable for the committee.

And the committee will now stand adjourned.

[Whereupon, at 12:15 p.m., the subcommittee was adjourned, to reconvene subject to the call of the Chair.]

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